ECOlogical observing System in the Adriatic Sea: oceanographic observations for biodiversity

Priority Axis 3: Environment and cultural heritage

Specific Objective 3.2: Contribute to protect and restore biodiversity

D4.2.1 Review of the knowledge of the target species at the selected Natura 2000 sites

WP4 – Establishing the Ecological Observing System in the Adriatic Sea (ECOAdS)
A4.2 – Integration of ecological observing system with Natura 2000 target species

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1. INTRODUCTION

This review aims to summarize currently available knowledge of target species at six Natura 2000 sites in the Adriatic Sea that were selected as case studies within the project ECOSS. The sites included are: Trezze San Pietro e Bardelli (IT3330009), Delta del Po (IT3270017 and IT3270023; two sites geographically overlapping and thus here combined), Tegnùe di Chioggia (IT3250047), Cres-Lošinj (HR3000161), Vis (HR3000469) and Malostonski Bay (HR4000015). For most of the Natura 2000 sites, the review is given for species listed as target species in the Standard Data Forms (SDF) of the selected sites (see Footnote for links to SDFs). For Delta del Po, only species of particular naturalistic or conservation interest are presented, based on expert opinion. The site Malostonski Bay is an exception as no target species are listed in the SDF, being focused on deliverying protection to target habitats. Nevertheless, for this site some species were included that are considered important based on expert opinion and because theira ssociation to the target habitats. Furthermore, some species were added for the Trezze San Pietro e [1]Bardelli, based on expert opinion of being relevant.

The information was collected via questionnaires (Annex I), from experts involved in research and monitoring programs at the selected Natura 2000 sites. For each species, a short description of biology and ecology is provided. Then, the overview of knowledge about the species in the whole Adriatic basin is given, followed with overview of knowledge of the species specifically for the selected Natura 2000 sites. For some sites for which no specific literature exists, the overview of knowledge for the wider or nearby region is given. This is particularly the case for the sites Tegnùe di Chioggia and Trezze San Pietro e Bardelli, due to their small size, and for Delta del Po for which most of the literature is focusing on wider surrounding area. Finally, tabular assessment of the available knowledge for each species is made along with the summary of its abundance and trend, spatial and temporal distribution at a corresponding Natura 2000 site.

[1]

Links to Standard Data Forms of the Natura 2000 sites included in this review:
Tegnùe di Chioggia - https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=IT3250047&release=10
Delta del Po - https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=IT3270017&release=10
Delta del Po - https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=IT3270023&release=10
Trezze San Pietro e Bardelli - https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=IT3330009&release=10
Cres-Lošinj - https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=HR3000161&release=10
Vis - https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=HR3000469&release=10
Malostonski Bay - https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=HR4000015&release=10

Based on the review of the available knowledge of the target species, the analysis on gaps in knowledge is provided to pinpoint the weaknesses and give directions as to where the future research and monitoring shall be directed.

With the information presented here, this review intends to complement other documents produced within the ECOSS project with a goal to develop the Ecological Observing System in the Adriatic Sea (ECOAdS). As such, it shall be regarded in a wider context, e.g. in combination with documents reviewing other important components, monitoring and management of the ecosystems in the Adriatic Sea, including:

D3.1.1 – Report on the assessment of existing ecological monitoring programs and observing systems
D3.2.1 - Report on the ecological monitoring, conservation strategies and management questions of Natura 2000 marine sites
D3.3.1 - Report on the key oceanographic processes and performance indicators for Natura 2000 marine sites
D3.4.1 - Report on the ESS to be used for monitoring ecological processes within the Natura 2000 sites
D3.5.1 - Long-term strategy and roadmap of the ecological observing system in the Adriatic Sea
D4.1.1 - Report on the characterization of the selected Natura 2000 sites
D4.1.2 - Report on the relationships between ecosystem-level management goals with ecological variables and oceanographic processes and the performance indicators
D4.2.2 - Report on the application of the conceptual model linking oceanographic processes, performance indicators and management questions for the target species
D4.2.3 - Report on the development of a local action plan and upscaling at the basin scale
D4.3.1 - Review of the knowledge of the ecological processes in the selected Natura 2000 sites
D4.3.2 - Report on the application of the models linking oceanographic processes and management questions
D4.3.3 - Report on the development of a local action plan and upscaling at the basin scale
D4.4.1 - Report on the interactions, synergies and gaps among the WFD, MSFD and H&BD for an effective management of the marine ecosystem
D5.1.1 - Report on data/information availability and infrastructure/tools requirements

Legend for the data on the assessment by the experts of the knowledge about the species and its status at a Natura 2000 site.

Codes for the assessment of existing knowledge about the species at a Natura 2000 site:

Code	Meaning
1	Nothing is known about this species at this site
2	Knowledge based on personal communication only
3	There is some knowledge in grey literature
4	There is some knowledge in peer reviewed literature
5	There is extensive peer reviewed literature about this species at this site

Codes for species' abundance at a Natura 2000 site

Code	Meaning
1	Increasing
2	Decreasing
3	Stable
4	No data

Codes for species' spatial distribution at a Natura 2000 site

Code	Meaning
1	Uniform distribution
2	Patchy distribution
3	Other – explanation given
4	No data

Codes for species' temporal distribution at a Natura 2000 site

Code	Meaning
1	Present year round
2	Seasonal presence (months when present are given)
3	Other – explanation given
4	No data

2. ALGAE

2.1 Fucus (*Fucus virsoides*)

Short description

Fucus virsoides is an endemic species in Adriatic Sea, found mainly in the northern Adriatic, from the Venice Lagoon in the north to Albania in the south (Mačić 2006). It inhabits the intertidal zone preferring clean environment without anthropogenic pressures. The pattern and abundance of *F. virsoides* is related to substratum configuration, air and water temperature, exposure to winds, and wave direction. *F. virsoides* prefers clean environment and habitats with specific trophic condition, therefore it was suggested to be included as an indicator for water quality in terms of good environmental status (GES) in the Adriatic.

F. virsoides has perennial flat dark brown thallus which is dichotomous branched, flattened and with a distinct midrib. The base of the thallus is attached to the rock by a basal plate. Gas-filled pneumatocysts (air-vesicles) are located around the midrib. Different structures are present on the thallus: tiny dotted structures -cryptosomes or sterile conceptacles and bigger swollen structures - receptacles or sterile conceptacles. Later contain many fertile cavities with the reproductive cells. Reproduction can be vegetative and sexual. Asexual reproduction occurs through fragmentation and the formation of adventitious branches, and sexual reproduction is oogamy. After meiosis oogonia and antheridia are produced and released, fertilisation follows, and the zygote develops directly into the diploid plant.

Relevance for the whole Adriatic Sea

Fucus virsoides is an endemic species in the Adriatic Sea and it used to be especially abundant in its northern parts (Batelli 2016; Iveša et al., 2009). Due to the reduced tidal movement in the Adriatic, *F. virsoides* inhabits a relatively narrow belt of the intertidal zone and on moderately exposed rocky sites. Growing urbanisation along the coast, the type of substratum, in addition to environmental factors, could be of crucial importance for algal recruitment and development and for the protection and maintenance of this endemic species and marine biodiversity in the Adriatic Sea.

Relevance for Natura 2000 site: Malostonski Bay (HR4000015)

The range of *Fucus virsoides* has decreased over the last decades (Orlando-Bonaca et al., 2013). Though it was common in Istria and northern Adriatic basin, over the last decades this species has disappeared or has become very rare at most sites (Zavodnik et al., 2002). *F. virsoides* inhabited southern Adriatic, but the lack of research and data on this species led to the presumption that it was no longer present here. Hence, recent record of *F. virsoides* in Malostonski Bay represents a valuable new data on its distribution (Marijana Pečarević, University of Dubrovnik, pers. comm.), and is the reason for call for inclusion of this species into the list of target species for this area. Special attention should be paid to major threats for this species' survival here, such as different human activities, as well as feeding of the sea urchins, which are very abundant in this area.

Assessment of the species at this site

Existing knowledge about this species at this site	3
Abundance	4
Spatial distribution	3 (present at only one locality)
Temporal distribution	4
Priority for further research and conservation	Monitoring and conservation measures and activities are needed (protection from sea urchins, sustainable use of the seashore and reduction of the pollution).

3. PLANTS

3.1 Virginia saltmarsh mallow (*Kosteletzkya pentacarpos*)

Short description

The species has a wide global range including eastern North America and the Mediterranean, and is considered "Vulnerable" (VU) (Buord et al., 2011). *Kosteletzkya pentacarpa* occurs in salty coastal marshes, deltas, along rivers, and depressions in sandy dunes on moist, light (sandy) to medium (loamy) soils with a wide pH range from acid to alkaline. The species is shade-intolerant.

Relevance for the whole Adriatic Sea

In Italy, this species is present in only two localities nowadays (Veneto and Emilia-Romagna) but six localities have been lost in Emilia-Romagna, Tuscany, Latium, and Campania. The European populations are severely fragmented. High agricultural and urban pressures have caused the loss of many localities of the species over the last decades (Pignatti 1982), leading to a particularly vulnerable status in Europe.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

In a wider region, the species is particularly abundant in Punta Sabbioni (Cavallino-Treporti, Venice) where it presents itself with a meta-population of different populations of individuals within a dominant community of *Juncus maritimus* (Ercole et al., 2013). Its presence is also noted in Valle Cannelle (Masin et al., 2008) and along the Nicesolo and Canadare canals in the Caorle lagoon (Masin et al., 2009).

The presence of this species is also noted in Delta del Po area. Here, the habitat loss and degradation due to drainage, pollution and urbanization, are the main threat to this species. Cleaning of the beaches is also impacting negatively on its habitat. Abandonment of grazing, tourist activities and the impact of winter storms on fragile dunes are further threats. Another potential threat is invasive *Baccharis halimifolia* L., appearance of which was recorded in the nearby populations of Punta Sabbioni (Ve). This species could cause problems over time, given its invasiveness (Ercole et al., 2013).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	Conservation of Site, population monitoring, creation of a genome resource bank and raising of public awareness are recommended.

3.2 Venice salicorne (*Salicornia veneta*)

Short description

Salicornia veneta is an annual species, growing in wet brackish environments, on dunes and muddy beaches submerged in winter. This species is not easily recognisable in the field. It is confused with *Salicornia europea* and therefore of uncertain distribution. It is a common species in the Lagoon of Venice, and does not seem to need conservation measures. It is known, however, that in its natural environment (in the "Barene" of the Lagoon of Venice) it is closely adapted to the level of salt water, which in turn depends on the tides: variation of a few centimeters causes the habitat of this plant to disappear, which is the reason for this species to be indicated among those at risk of extinction (Buffa et al., 2016).

Relevance for the whole Adriatic Sea

Salicornia veneta is endemic to the Mediterranean, extending to Croatia, Italy (Lagoon of Venice, Delta Po, Sardinia) and Slovenia. According to Conti et al. (2005) and Arrigoni (2006) *S. veneta* is present in northeast Italy and in Sardinia in only one locality. The species has a very restricted range and the area of occupancy is believed to be less than 500 km².

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

Salicornia veneta is relatively common over its distribution area, although in regression due to human degradation of its coastal habitats, justifiying its inclusion in the list of target species. Populations are vigorous but the type of required habitat is rare and under much pressure from tourism development. The brackish environments of the northern Adriatic coast, including this site, where *Salicornia veneta* develops are strongly damaged by human activities such as tourism but also industrialization, aquaculture, urbanization. Pollution (nitrification) and vegetation succession might also have an impact on the species. The use of the plant is currently very limited, but the harversting of the young shoots can compromise the species reproductive capabilities.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	Future recommended conservation measures are: legal protection (lists of protected species in Croatia and Slovenia), application of legal measures of conservation, monitoring of the sub-populations and search for new ones, evaluation of the size of populations, study of the dynamics of populations, study of the biology and ecology of the species.

3.3 Slender seagrass (*Cymodocea nodosa*)

Short description

Cymodocea nodosa is a seagrass species of narrow, up to forty centimetres long, light green or greyish-green leaves in the family Cymodoceaceae which is found in shallow parts of the Mediterranean Sea and certain areas of the Atlantic Ocean. Each leaf has seven to nine veins running along its length. The plant produces rhizomes, which are only 1 mm in diameter with leaf scars. Inconspicuous flowers at the end

of long stems appear in the spring when water temperatures begin to rise after their winter minimum. The pollen is liberated into the sea and the seeds remain dormant until the following spring. Slender seagrass grows in meadows on the seabed at depths of down to ten metres in soft sediments in sheltered bays and needs clear waters for photosynthesis. Many different species of epiphytic algae grow on the leaves and rhizomes of *C. nodosa*.

Seagrass meadows have high biological productivity and are rich, biodiverse habitats with numerous associated fish and invertebrate species. The meadows are an important rearing ground for juvenile fish. *C. nodosa* tends to grow in patches, because it favours unstable sandy sediments and subaqueous dunes tend to move over time. If the sand accretion is not too fast, the stolons can grow vertically through it, but the seagrass can be overwhelmed by rapid accretion. Patch death was mostly caused by erosion as roots were uncovered, encrusting and drilling organisms increased and plants were swept away. The dune movement cycle tended to take two to six years, which gives the seagrass time to recolonise bare areas. Sand accretion also stimulates flowering and dormant seeds can enable recolonization when conditions allow it. It is adversely affected by mechanical disturbance such as trawling and by pollution, and although it is in competition with other seagrass species, *C. nodosa* is not considered to be threatened. The invasive alga *Caulerpa taxifolia* is often associated with *C. nodosa*.

Relevance for the whole Adriatic Sea

Cymodocea nodosa is common throughout the Mediterranean. The overall population is thought to be stable, but a regression was noted in the northern Adriatic Sea (Guidetti et al., 2001). In Lagoon of Venice, for instance, this species was once abundant throughout the lagoon, but its retraction away from the urban waters of Venice and Porto Maghera was noted by the 1984 (Sfriso, 1987). A later study revealed the extension of its range within the lagoon where it is the most abundant macrophyte nowadays (Sfriso & Facca, 2007). *Cymodocea nodosa* is threatened locally by mechanical damage from trawling and anchoring from boats and coastal development (Orlando-Bonaca et al., 2015). Eutrophication is also a problem. This species is found in coastal regions where there is a high level of human disturbance. It is however, a relatively resistant species.

Relevance for Natura 2000 site: Malostonski Bay (HR4000015)

Seagrass meadows here have high biological productivity and are rich, biodiverse habitats with numerous associated fish and invertebrate species. The meadows are an important rearing ground for

juvenile fish (Marijana Pečarević, University of Dubrovnik, pers. comm.), which calls for addition of this species to the list of target species for this area.

Assessment of the species at this site

Existing knowledge about this species at this site	3
Abundance	3
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	The relevant mapping of the population should be done.

4. SPONGES

4.1 Geody (*Geodia cydonium*)

Short description

This porifer, commonly called geody or white ball, has a spheroidal shape with a large osculum at the top. The specimens can reach up to 70-80 centimeters in diameter. The color varies between white and yellowish to yellow grey. It is often colonized by organisms that cover it in whole or in part and that do not allow, sometimes, to observe its color on the surface. Sometimes a layer of sediment is deposited on it, which makes it even less visible. This species is mainly found on sediment-rich bottoms, at depths between 15 and 25 meters. It can rarely be observed along the rocky coast where the conditions are less favorable to their optimal growth.

Geodia cydonium plays a very special ecological role because it hosts a large number of smaller species. The reason is related to its anatomy: it has numerous wide channels that present optimal shelters for small fish and crustaceans. Its protection is therefore essential to ensure the survival of the species related to it. According to available studies, the abundance and richness of the populations associated with the sponge do not appear to vary from area to area, showing that associations, of which this poriferan is an essential and indispensable part, are stable and not random and therefore of greater ecological importance.

Geodia cydonium is a typically Mediterranean species that is widespread in Italy along all coastal regions, although it shows some fragmentation.

Relevance for the whole Adriatic Sea

In the Adriatic Sea, where there are relevant colonies of this poriferous, 28 species have been recorded to exploit the geody as host. Among these are: small crustaceans *Apseudopsis acutifrons* and *Leptochelia savignyi*, and the polychaetes *Ceratonereis costae* and *Sphaerosyllis bulbous*. There are also many species that take advantage of geody during their juvenile stages, for example as a refuge, demonstrating its function as an important organism to promote repopulation.

Relevance for Natura 2000 site: Trezze San Pietro e Bardelli (IT3330009)

Geody plays and important ecological role at this site as it presents a host for numerous other species. It also participates in bioconstruction process (Falace et al., 2015). Even though geody is currently not included in the list of target species in the Standard Data Form for this site, it should be regarded as target species due to its ecological significance at this site.

Assessment of the species at this site

Existing knowledge about this species at this site	3
Abundance	3
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	Associated fauna

5. CORALS

5.1 Cushion coral (*Cladocora caespitosa*)

Short description

The cushion coral is a colonial species, living in symbiosis with algae at shallow depths, usually between 6 and 20 meters on rocky bottoms also covered by photophilic algae. It can rarely be found at depths below 20 meters, if the local conditions permit enough light for photosynthesis for the symbiotic zooxanthellae (Kružić & Benković, 2008). The *C. caespitosa* includes zooxanthellae unicellular algae in their tissues like tropical madreporari. Nutrition, however, occurs mainly by catching food particles (heterotrophic), supplemented by autotrophic nutrition (provided by zooxanthellae) in small parts and only in colonies exposed to sufficient light. A colony lives in the wild for many decades (>60 years).

This species is assessed as "Endangered" (EN) by the IUCN, with population marked as decreasing. Slow growth dynamics limit the capability of the species to recover from negative impacts. The major threats include seawater warming, trawling and dredging, eutrophication and sewage discharges (Casado de Amezua et al., 2015).

Relevance for the whole Adriatic Sea

The species is present throughout the Adriatic basin with notable populations recorded at several sites along the eastern coast. The largest population is found in Veliko Jezero, National park Mljet, where it covers an area of 650 m^2, at depths from 6 to 18 m (Kružić and Požar-Domac, 2003). Other notable locations are: Prvić Island, Pag Island and Iž Island. The species has gone through a major decline in the Adriatic Sea in the last decades, caused by industrial and sewage discharges, trawling, coastal development and seawater warming (Casado de Amezua et al., 2015).

Relevance for Natura 2000 site: Trezze San Pietro e Bardelli (IT3330009)

The presence of this species at this site has been noted as rare. However, this species has been noted as important bio-constructor in several locations in the Adriatic Sea (Falace et al., 2015). Although currently

not one of the target species for this site, it should be included due to its ecological role as bioconstructor (Saul Ciriaco, Shoreline, pers. comm.)

Assessment of the species at this site

Existing knowledge about this species at this site	3
Abundance	4
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	Abundance

6. MOLLUSCS

6.1 Date mussel (*Litophaga litophaga*)

Short description

Lithophaga lithophaga is an endolithic bivalve which bores calcareous substrata by glandular secretion. It is widespread in the infralittoral, usually at shallow depths, of the Mediterranean, and certain Atlantic areas. Date mussel harvest is illegal in the majority of Mediterranean countries. However, due to the extremely high price and demand for this mollusc, shallow rocky habitats are heavily threatened by this human activity which leads to the desertification of tens of kilometres of the Mediterranean rocky coast each year. In natural populations, date mussels of length 1 cm are approximately 3 years old. It is noticed that larger individuals can reach up to 40 years. Date mussels also colonize limestone artificial structures, growth seems to be higher in artificial than in natural structures.

The shells of species in this genus are long and narrow with parallel sides. The animals bore into stone or coral rock with the help of pallial gland secretions. The reproductive cycle of *L. lithophaga* is known from laboratory analyses of gonadial development. It is dioecious and although hermaphroditism has been observed occasionally this is possibly induced by pollution and endocrine disruption. Sex ratio depends on size. *L. lithophaga* becomes reproductively active at an age of 2 years, with a single reproductive cycle per year. Gonad maturation begins in spring and individuals become mature at the end of summer.

Relevance for the whole Adriatic Sea

Because the species lives inside rocks, environmental problems result from its harvesting since rocks must be broken up to expose individuals for collection. Such destructive exploitation has affected extensive coastal areas throughout the Mediterranean and Adriatic Sea and produced large scale negative impacts on associated benthic communities, which both cover and live inside the rock (Žuljević et al., 2018). It is protected in many countries by national laws, and the Bern Convention as a 'Strictly Protected Faunal Species', the European Habitat Directive as a 'Fauna and Flora Species of Community Interest that Require Strict Protection' and the Barcelona Convention where it is included in the 'List of Endangered or Treatened Species'.

Relevance for Natura 2000 site: Malostonski Bay (HR4000015)

This area represents a part of the natural habitat for *L. litophaga*. Although extact information on its abundance and biometric patterns is currently missing for this site, it is clearly under threat due to illegal harvesting through destruction of rocky substratum with special sledgehammers. This also has a detrimental effect on organisms living on the surface and within the substratum (Marijana Pečarević, University of Dubrovnik, pers. comm.). The species is currently not listed as target species for this site, but is listed here as its protection would yield positive effects on its wider habitat.

Assesment of the species's at this site

Existing knowledge about this species at this site	2
Abundance	4
Spatial distribution	4
Temporal distribution	1
Priority for further research and conservation	Information about date mussels' biometric patterns is important in planning studies assessing the resilience capability of natural populations after illegal destructive harvesting.

6.2 Noble pen shell (*Pinna nobilis*)

Short description

Pinna nobilis Linnaeus 1758 (Bivalvia: Pinnidae) is the largest Mediterranean bivalve species that can reach up to 120 cm of shell length, but it is usually 30–50 cm long. It is relatively sensitive to pollution and shell damage. Anterior third of its triangular shell is being buried into soft sediment attached to rocks under the sediment using a strong byssus. The animal secretes byssus fibers from its byssus gland; they consist of keratin and other proteins and may be as long as 6 cm. *P. nobilis* hosts symbiotic shrimp which live inside its shell which has a similar filter-feeding diet to its host and the relationship is likely mutualistic.

Fan mussel is filter-feeding organism, its diet consists predominantly of sludge detritus and phytoplankton and both components are necessary. Specimens of different sizes, which live in low

energy environment, feed on different phytoplankton and zooplankton. *P. nobilis* is a successive hermaphrodite, gametes mature asynchronously. Gametogenesis runs from March to June, followed by alternating spawning and rapid gametogenesis by August. The fertilization is external and followed by the development of veliger larvae. The period of planktonic larvae lasts about ten days, after which it settles to sediment.

Fan mussel is endemic to the Mediterranean Sea, where it lives offshore at depths ranging between 0.5 and 60 m. It is classified as a species of Community Interest in need of strict protection by the European Habitats Directive and as an Endangered Species by the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean from the Barcelona Convention. Since 2016, a devastating and geographically widespread mass mortality event has impacted *P. nobilis* populations throughout the Mediterranean Sea.

Relevance for the whole Adriatic Sea

Currently, the ongoing mass mortality event, due to the parasite *Haplosporidium pinnae*, is the most worrying and widespread threat to *P. nobilis* throughout the Mediterranean Sea (Catanese et al., 2018). At the eastern Adriatic coast there are still areas which are not affected by mass mortality events that are spread from western Mediterranean eastwards.

Relevance for Natura 2000 site: Malostonski Bay (HR4000015)

By the autumn 2019, abundant healthy population of *P. nobilis* with a large filtering capacity was present in the Malostonski Bay, from 0.5 m of depth to the deeper habitats, and the area is considered as suitable habitat for the species (Marijana Pečarević, University of Dubrovnik, pers. comm.). At the moment, the population is decreasing rapidly, it is endangered not only by earlier identified anthropogenic threats, but also by the parasite *H. pinnae* and it is assessed as a Critically Endangered by the IUCN (Catanese et al., 2018). Continuous monitoring of the species populations is mandatory, and preferably inclusion of this species in the list of target species for this site.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	Continuous monitoring of the species populations especially of juveniles

7. FISH

7.1 Adriatic sturgeon (*Acipenser naccarii*)

Short description

The Adriatic sturgeon is a species of fish in the family Acipenseridae that can grow to a maximum length of about 2 m (6.6 ft) and a maximum weight of 25 kg (55 lb). Like other sturgeons, it has an elongated body, a flattened rostrum, a cartilaginous skeleton, distinctive bony scutes, and an elongated upper lobe to its tail. The Adriatic sturgeon is an anadromous fish and can be found at different periods of its life in freshwater and marine environments, including estuaries and brackish water. Sturgeons are slow-growing, long-lived fish and do not reach sexual maturity until they are 15 to 20 years old. After the young fish have spent a period of growth in estuaries and coastal waters, they spend most of their lives in large rivers, foraging on the bottom for crustaceans and small fish which they suck up with their toothless, funnel-like mouths. Mature fish move upstream in spring to spawn in shallow, clear-water, gravelly areas.

Relevance for the whole Adriatic Sea

The species is endemic to the Adriatic Sea basin. In Italy it survives with a small population in a historical breeding area located at the confluence of the Po and Ticino rivers (Kottelat & Frehyof, 2007). Sporadic specimens are captured following reintroduction plans in watercourses in the Po Valley-Veneto fishery district, without evidence of acclimatization.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

Many of the traditional spawning areas of this species are no longer available because of the impoundment of rivers, and the only suitable remaining habitat for spawning is thought to be in the vicinity of the confluence of the River Po with its tributaries (Bronzi et al., 2011). The species can be considered close to extinction and currently depends almost exclusively on the artificial reproduction actions on the farms and on the restocking in nature. Therefore, it is assessed as “Critically Endangered” (CR) by the IUCN, based on an estimate of the decline of more than 80% in the past three generations, mainly due to the alteration of the habitat, and because it is estimated that the mature individuals are less than 50.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	There is no data on the consistency of the regional, national and neighboring population, therefore it is not possible to define quantifications on the population at local level.

7.2 Twaite shad (*Alosa fallax*)

Short description

Twaite shad is an anadromous fish in the family Clupeidae. It has a row of six to ten distinctive spots on its silvery flanks. *Alosa fallax* primarily lives at sea on feeding grounds and migrates to spawning grounds between April and June once sexually mature (Coscia et al., 2010). Maturity usually ranges from 3–7 years of age. Juveniles appear in estuaries and brackish water around June to July (Lochet et al., 2009). It is estimated that the estuarine phase, or the time that they are in the estuaries migrating from spawning grounds to sea, has a duration in *A. fallax* of up to a year and a half. Currently the migration takes place rarely outside the ebb and flow limits of the tide but, before the creation of impassable barriers on the main rivers, these fish went up the rivers for considerable distances.

Relevance for the whole Adriatic Sea

The distribution area includes most of the rivers along all the Italian coasts. Present in the large rivers of the Veneto (Piave, Brenta and Tagliamento). There are reproductive populations found in the Po up to the barrier of Isola Serafini. Populations have been reduced primarily through overfishing, pollution, habitat destruction and migratory route obstruction.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

The population inhabiting the Delta del Po is in strong contraction with few residual populations (>50% population reduction in 10 years), due to a decline in habitat quality (Bianco, 2002), justifiying its inclusion as a target species for this site. The migratory flow affecting Delta del Po takes place mainly through the "Po di Levante", characterized by more constant flow rates and better water quality than the other branches. *A. fallax* can use also the water lagoons for its rising rivers. Individuals in migration are usually reported in lagoons such as "Barbamarco", "Burcio-Batteria", "Allagamento", "Scardovari" e "Basson", especially during the peak of the migration, usually in May (Verza & Cattozzo, 2015).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	2
Temporal distribution	2 (Apr, May, Jun, Jul, Aug, Sep)
Priority for further research and conservation	Further studies on *A. fallax* genetic, distribution and abundance in the area, structure and quality of the river habitat, are needed for the understanding any critical issues in need of intervention.

Relevance for Natura 2000 site: Trezze San Pietro e Bardelli (IT3330009)

This species is listed in the Standard Data Form for this site, but no verifiable sources of knowledge exist for this species at this site, other than its recorded presence (Saul Ciriaco, Shoreline, pers. comm.).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	4
Temporal distribution	4
Priority for further research and conservation	Presence, abundance

7.3 Adriatic dwarf goby (*Knipowitschia panizzae*)

Short description

A short-lived species (less than 2 years). It is present in brackish lagoonal and estuarine waters (introduced into freshwater). It lives not only on bare soft substrates, rich in the empty shells of bivalves, but also on substrates occupied by eelgrass or algae. In the Lagoon of Venice, it primarily occupies coves with soft, especially muddy bottoms, with turbid waters relatively low in salinity (8-25‰) (Malavasi et al., 2004; Malavasi et al., 2005; Franco et al., 2006). The adults disappear after spawning, during their second summer of life, in April-August. Females may spawn every 10-15 days during the season. The male, although smaller than the females, grow more rapidly. The male defends eggs in cavities under stones, plant material or shells; may overturn and clean suitable shells for spawning and these are then covered with substrate. Postlarvae are pelagic.

Relevance for the whole Adriatic Sea

This species shows sub-endemism in central and northern Italy, with an original area restricted to the Adriatic basin. It is present in the coastal lakes of the Po Delta and the Lagoon of Venice (Malavasi et al., 2005). Two categories of habitats contribute to sustainment of the highly diversified fish assemblages in shallow waters of the Lagoon of Venice: ‘‘structuring’’ habitats, like seagrasses and saltmarsh creeks, where a specialized and recognizable fish assemblage can be found, and ‘‘transition’’ habitats (sandy bottoms, mudflats and sparsely vegetated habitats), where fish assemblages are highly variable and influenced by the contribution of the adjacent habitats (Malavasi et al., 2005).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

The varieties of this species are abundant at this site and expanding even outside the natural range. The species is extremely important in trophic networks because it creates very large populations (Turin, pers. comm.).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	3
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	The management and conservation of the fish communities of the lagoon requires a constant monitoring of the two habitat categories (Franco et al., 2006).

7.4 Po brook lamprey (*Lampetra zanandreai*)

Short description

The Po brook lamprey is a species of lamprey in the Petromyzontidae family that lives mainly in the alpine mountainside of Po basin, in Veneto and in Friuli-Venezia Giulia regions. *L. zanandreai* is of moderate size (max size of adults 190 mm in TL in the Po system) (Bianco, 1986), but with variations in the average body length in the Po, Adige and some rivers emptying into the northern Adriatic Sea. The Po brook lamprey lives in clean, cold water usually near springs in the foot-hill zone, over muddy or sandy bottom. The temperature at which *L. zanadreai* lives ranges from 5°C in winter to 19,5°C in summer. Ammocoetes inhabits detritus-rich sands or clay sediments. Adult does not feed, while the ammocoetes are filtering bottom-feeders. Metamorphosis takes place after 4.5 years, and sexual maturity is reached from 5 to 10 months after the biginning of metamorphosis. Reproduction takes place from January to June, usually between January and March. It is a non-parasitic lamprey. It requires a gravel substrate. The larvae remain hidden in the gravel for 3-5 years then the adult emerges and spawns over a one-month period in summer. The life of the adult does not exceed 6 - 8 months (Bianco, 1986). Is not a migratory species; however passive transportation as well as short up and downstream movements may occur.

Relevance for the whole Adriatic Sea

Restricted to the upper Adriatic river drainages, including northern Italy, the Adriatic basin of Slovenia and Croatia (Neretva and Matica rivers). Its existence is threatened by habitat destruction and water abstraction.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

The Po brook lamprey is an endemic species of the Padan Plain. All populations have seen a sharp decline in the past 10 years (Caputo et al., 2009) due to fragmented and continuously declining area, loss of habitat quality due to canalization, construction of barriers and river works, water withdrawals, water pollution.

Assessment of the species at this site

Existing knowledge about this species at this site	1
Abundance	4
Spatial distribution	3 (no evidence of presence at this site)
Temporal distribution	4
Priority for further research and conservation	It is important to conduct surveys at times when the adults have emerged in the summer.

7.5 Sea lamprey (*Petromyzon marinus*)

Short description

The sea lamprey is a parasitic lamprey, native to the Northern Hemisphere. Due to its lifecycle that switches between fresh and salt water, the sea lamprey is adapted to tolerate a wide range of salinities. Lampreys are anadromous; from sea habitats, they migrate up rivers to spawn. Females deposit a large number of eggs in nests made by males in the substrate of streams with moderately strong current. Spawning is followed by the death of the adults. Larvae burrow in the sand and silt bottom in quiet water downstream from spawning areas and filter-feed on plankton and detritus. After several years in freshwater habitats, the larvae undergo a metamorphosis that allows young, post-metamorphic lampreys to migrate to the sea, and start the adult hematophagous method of feeding (Silva et al., 2013a). Some individuals start hematophagous feeding in the river before migrating to the sea (Silva et al., 2013b), where sea lampreys prey on a wide variety of fish (Silva et al., 2014). After one year of hematophagous feeding, lampreys return to the river to spawn and die, a year and a half after the completion of metamorphosis (Silva et al., 2013c).

Relevance for the whole Adriatic Sea

The numerical consistency of the *P. marinus* population in Italy is less than 50 individuals and is present with only one reproductive population in the Magra river (Ciuffardi et al. 2007). For these reasons it is registered in Red List with "CR" (Critical Threatened).

A recent study provided the first direct evidence of sea lamprey parasitism on bottlenose dolphin, *Tursiops truncatus*, recorded between the islands of Mljet and Korčula (Croatia) (Miočić-Stošić et al. 2020). Indirect evidence suggests that the occurrence of sea lamprey parasitism on bottlenose dolphins and its potential impact on population level is low.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

This is generally a rare species, especially in the Mediterranean Sea. No records exist specifically for the Delta del Po Natura 2000 site, and recently only single erratic specimens have been found in the nearby Lagoon of Venice (Mizzan, 2007), the port of Chioggia and the Lido di Jesolo (Fiorin et al., 2017).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	4
Temporal distribution	1
Priority for further research and conservation	Further studies on *P. marinus* are needed for understanding trends in reproductive patterns and the influence of habitat features on reproductive success.

7.6 Canestrini's goby (*Pomatoschistus canestrinii*)

Short description

This is a species of goby native to fresh and brackish waters along the Adriatic coasts where it is known to occur from the Delta del Po in Italy to Montenegro. It has also been introduced in Lake Trasimeno (Freyhof 2018). The species has recently been placed in genus *Ninnigobius* (Geiger et al., 2014). This

species prefers inshore habitats, estuaries, brackish- and fresh-water lagoons, lakes and large to medium size rivers, on sand or mud bottom. It is found mainly on open sand or mud bottom. It can reach a length of 5.5 centimetres (2.2 in). Its life span is one year on average. The Canestrini's goby spawns in March to July period. Individual females spawn several times (up to 10 times) during a season. Adhesive eggs are deposited under or between stones, shells and aquatic plants. Males guard eggs until hatching. The larvae are pelagic. The species feeds on a wide variety of benthic invertebrates (Freyhof 2018).

Relevance for the whole Adriatic Sea

Within the European Union the species is only known from the north-western Italian to Montenegrin inshore/estuarine habitats with an extent of occurrence estimated to approximately 5,000 km^2. However, the species is abundant and has no known major threats (Freyhof 2018).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

Until 10 years ago the populations in the Delta del Po appeared very fluctuating. The areas in which this species lives are often affected by industrial pollution and eutrophication. Nonetheless, the species appears to be in good condition and expanding (Freyhof 2018).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	Further studies on *P. canestrinii* are needed for understanding population trends in the site. The main threats concern the alteration of the coastal transition environments with particular reference to anthropic activities concerning shellfish farming, pollution and dystrophic crises in the lagoons.

8. AMPHIBIANS

8.1 Common spadefoot (*Pelobates fuscus*)

Short description

Two subspecies are traditionally recognised: *Pelobates fuscus fuscus* (from central Europe) and *Pelobates fuscus insubricus* (from Northern Italy). Taxonomic studies are underway on this species; it seems possible that it is actually a complex of species (Temple & Cox 2009, Litvinchuk et al. 2013). The species is present in open plains areas, where it prefers areas with soft soils (sandy or rich in organic matter), in clearings between the deciduous and coniferous forests, cultivated fields (which he seems to avoid in favor of uncultivated and stable meadows), stable meadows, poplar groves, rice fields (where in the last decade he has disappeared due to new cultivation practices), parks and gardens (Andreone et al. in Lanza et al. 2007). It reproduces in small collections of water, preferably temporary. The generation time is approximately 4 years.

Relevance for the whole Adriatic Sea

In Italy it has a very limited distribution, being present exclusively in northern Italy (Padano-Veneta plain), where it is present in a small number in very isolated locations.

Relevance for Natura 2000 site: Delta Po (IT3270017 and IT3270023)

The population of *P. fuscus insubricus* present in Porto Caleri is the only spontaneous one currently widespread in Veneto (Richard, 2007; Richard & Tenan, 2008). It is an isolated population and, with the exception of the one recently introduced in Bosco Nordio, the closest population is located 20 km south, in the Emilia region (Richard, 2007). The population of Porto Caleri, with a maximum of 63 breeding adults surveyed in the same year and a total of 238 individuals surveyed in eight years of monitoring is, as far as is known, the largest in north-eastern Italy (Spagnol et al, 2016).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	3 (localized distribution)
Temporal distribution	1
Priority for further research and conservation	The biology and the distribution of the species remains little known and it is not yet clear which are the main factors that determine its rarefaction.

9. REPTILES

9.1 Loggerhead turtle (*Caretta caretta*)

Short description

The loggerhead turtle has a wide distribution across moderate and tropical areas of Pacific, Indian and Atlantic oceans, including the Mediterranean Sea. The adults reach the average carapace lengths of 90 cm and weight of 135 kg. The species is characterized with a life span of 47 to 67 years, late sexual maturity (17 to 33 years) and a low reproductive rate. The primary habitat is saltwater, occasionally estuarine, and females briefly come on land to lay eggs. The diet is predominantly composed of bottom-dwelling invertebrates, but can also include algae, vascular plants, squid and fish.

According to IUCN, the loggerhead turtle is categorized as “vulnerable” (VU) at global scale, whereas at the Mediterranean scale it is categorized as “least concern” (LC).

Relevance for the whole Adriatic Sea

In Mediterranean, more than 96% of nesting occurs in Greece, Turkey, Libya and Cyprus. Therefore, even though a few scattered nests were reported for Italy, the Adriatic Sea is not considered as nesting site. This is further corroborated by the absence of evidence of nesting along the eastern Adriatic coast (Casale et al. 2018).

Nevertheless, the continental shelf area with depths under 200 m, rich benthic fauna and favorable temperature ranges make the northern and central Adriatic Sea one of the largest and critical neritic foraging habitats of the loggerhead turtles in the Mediterranean. Here, both juvenile and adult individuals are evidenced, majority of them originating from the nesting sites in Greece (Lazar & Tvrtković 2003) and lower proportion from Turkey and Cyprus (Lazar et al. 2004).

Relevance for Natura 2000 site: Trezze San Pietro e Bardelli (IT3330009) and Tegnùe di Chioggia (IT3250047)

Due to geographical proximity and ecological similarity, the relevance of the loggerhead turtle is given here for both sites. Furthermore, no study on loggerhead turtles addresses solely these two sites, hence

the knowledge presented here is extrapolated from studies encompassing the wider northern Adriatic region.

Studies based on catch rates, flipper tagging, satellite tracking and strandings indicate the relative importance of the northern Adriatic, within the Mediterranean context, as a neritic habitat for loggerhead turtles (Casale et al. 2018). This is further corroborated by aerial surveys, conducted in 2010 and 2013, which have shown that the northern Adriatic Sea, including these Natura 2000 sites, is an area with highest predicted surface densities for the loggerhead turtles in the Adriatic (Fortuna et al. 2018). Based on those data, the minimum density per surface for these two sites is 20 individuals/100 km^2. Site-fidelity, at least for some of the individuals, has also been noted base on flipper tagging data (Lazar et al. 2004). Taking into consideration the benthic feeding strategy and overwintering behavior of the species, the seafloor of the northern Adriatic is proposed to be considered as "critical habitat" for the Mediterranean regional management unit (RMU) (Fortuna et al. 2018).

Due to high densities recorded here, the loggerhead turtle plays an important role in maintaining the ecological balance at the Trezze San Pietro e Bardelli and Tegnùe di Chioggia sites. For instance, the loggerhead turtles were found to have a significant role as bio-turbators in northern Adriatic. They contribute to natural recycling of benthic environments through crushing and expelling the mollusc shells which accelerates the rate of shell disintegration and increases substrate surface available for colonization by burrowing invertebrates. Through infaunal mining loggerhead turtles mix sediment layers, influence its texture and compaction, and promote bio-irrigation, dispersal of solid particles and nutrient transport between sediment layers (Lazar et al. 2011).

Fisheries interactions are the main threat to loggerhead turtles in the northern Adriatic, with gill nets identified as the most lethal fishing tools (Lazar et al. 2004). The study of Lazar and Gračan (2011) found that one third of the examined loggerhead turtle carcasses collected mostly in the northern Adriatic contained ingested marine debris, indicating the physical pollution as a potential threat.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	Population trends, post-bycatch survival rates

9.2 European pond turtle (*Emys orbicularis*)

Short description

The European pond turtle is a species of long-living freshwater turtle with the usual life span of 40–60 years. It is the autochthonous aquatic tortoise species in Italy and it is mainly distributed along the coast and areas at low elevation. In Italy populations are mainly found in two different kinds of habitat: "pond" systems, consisting of one or more natural, shallow water bodies, generally in forest areas, and the "canal" habitat, which is characterised by artificial drainage canals, generally in open or marginal areas. It also feeds in upland environments and eats a mixed diet of plants and animal. It is usually considered semi-aquatic, as its terrestrial movements can span 1 km, and it is occasionally found travelling up to 4 km away from the water (Ficetola & De Bernardi, 2006). Suitable nesting areas are bushy, sunny clearings with marly-limestone soil, situated on slopes or at the base of small landslides. Nest fidelity is a characteristic that female carry out by selecting a nesting site based on its ecological characteristics and then return there for future expeditions so long as the site has not changed (Mitrus, 2006).

Relevance for the whole Adriatic Sea

Most of the largest Italian populations are found in nature parks, biological reserves, and protected areas. In the national territory and also in the Padan plain the species has undergone a strong decline in the last three generations due to drainage of water basins, modification of their banks, current practices of mechanical control of riparian vegetation, removal of bottom sediments in canals, possibly also by competition with the introduced Red-eared terrapin (Zuffi et al. in Corti et al. 2010; Bonato et al., 2007).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

E. orbicularis occurs sporadically in several areas in north-western Italy (Societas Herpetologica Italica, 1996). In Veneto it is common in coastal areas, limited and isolated in the remaining lowlands. The largest population is made up of <1000 mature individuals (Bonato et al., 2007).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	Further studies on *E. orbicularis* are needed for understanding of latitudinal and altitudinal trends in reproductive patterns, the influence of habitat features on reproductive success, determine the reproductive parameters responsible for long-term population dynamics, and human pressure (Zuffi, 2000).

10. BIRDS

10.1 Mediterranean gull (*Larus melanocephalus*)

Short description

The mediterranean gull has historically had a distribution around the Black Sea, and in central Turkey, with expansion in recent decades to most of the Europe. The breeding sites include reed beds, marshes and lake islands. The species is opportunistic omnivore, preferring coastal zones and open sea areas above continental shelf. Due to its large population size and distribution, it is considered as "Least concern" (LC)

Relevance for the whole Adriatic Sea

In relation to other European sites, the population of the Mediterranean gull in the Adriatic is relatively small, with a patchy distribution. Its presence is noted in several sites along the Italian Adriatic coast, with some of them used also as breeding sites. The foraging behavior of the Mediterranean gull in this area was found to be primarily directed at open sea, fishing boats and aquaculture sites (Fasola et al., 1989).

Relevance for Natura 2000 site: Trezze San Pietro e Bardelli (IT3330009)

This species is listed in the Standard Data Form for this site, but no verifiable sources of knowledge exist for this species at this site, other than its recorded presence (Saul Ciriaco, Shoreline, pers. comm.).

Assessment of the species at this site

Existing knowledge about this species at this site	1
Abundance	4
Spatial distribution	4
Temporal distribution	4
Priority for further research and conservation	Distribution

10.2 Mediterranean shag (*Phalacrocorax aristotelis desmarestii*)

Short description

Mediterranean shag, *Phalacrocorax aristotelis desmaresti* blongs to the cormorant family. Its range is within the Mediterranean and the Black Sea. These are foot-propelled diving seabirds. The diet varies depending on annual changes in prey availability and, to a lesser extent, on location. The species feeds on a wide range of benthic, demersal and schooling pelagic fish, and for this reason it is classified as opportunistic in its feeding habits. Foraging areas have depths ranging between 7 and 80 m, with a mean of 30 m, and are usually between 7 and 17 km around the breeding colonies. It is a colonially breeding species, breeding at rocky shores, with a preference for native grounds also in the adulthood.

Relevance for the whole Adriatic Sea

In the Adriatic Sea, the breeding grounds of the European shag are almost exclusively situated along the Croatian coast. The number of breeding pairs here is estimated at around 2000, with majority of them (1300-1500) in northern and central Adriatic. The post-breeding migratory behavior displaces majority of individuals to distant feeding and roosting grounds. The most notable migration route is between breeding sites in Croatian part of northern Adriatic and the Gulf of Trieste, where the species forages in late summer and autumn (Sponza et al. 2013; Škornik et al., 2012). Recently, the Venice lagoon was identified as a newly established migration destination. The number of individuals using the Gulf of Trieste for foraging and roosting is estimated to represent up to 33% of the Mediterranean non-breeding population (Koce 2018).

Diet analysis shows preference for demersal fish in the Gulf of Trieste and bentho-pelagic mobile prey along the Croatian coast. The lack of benthic prey in Croatia due to overfishing was proposed as a cause for the displacements to shallower parts of the northern Adriatic, rich in benthic prey, which represent more favorable foraging grounds (Casolo et al., 2011; Casolo et al., 2012).

Relevance for Natura 2000 site: Trezze San Pietro e Bardelli (IT3330009)

This species is listed in the Standard Data Form for this site, but no verifiable sources of knowledge exist for this species at this site, other than its recorded presence (Saul Ciriaco, Shoreline, pers. comm.).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	4
Temporal distribution	4
Priority for further research and conservation	Distribution, diet and reproduction

10.3 Yelkouan shearwater (*Puffinus yelkouan*)

Short description

The yelkouan shearwater is a Mediterranean endemic species. It forages in pelagic areas and nests mainly on the islands furthest from the mainland in colonies on the high, rocky coasts. The main threats are degradation of nesting sites due to urbanization and predation by terrestrial mammals.

Relevance for the whole Adriatic Sea

The Adriatic Sea is considered to be one of the important areas for moulting, feeding and passage during the interbreeding period for the Yelkouan shearwater. The period of highest occurrence is between June and October and the overall trend in occurrence is decreasing. Migrations from the breeding sites as far as Malta to the Adriatic Sea have been recorded (Bourgeois & Vidal 2008).

The species is included in Annex II of the SPA/BIO Protocol to the Barcelona Convention, in Annex II of the Berne Convention, in Annex I of the Birds Directive.

Relevance for Natura 2000 site: Trezze San Pietro e Bardelli (IT3330009)

No study aimed specifically at this site exists. The nearest area with existing records is the Gulf of Trieste where up to 1000 individuals are recorded within the June to October period of occurrence (Brichetti & Fracasso, 2003)

Assessment of the species at this site

Existing knowledge about this species at this site	2
Abundance	4
Spatial distribution	4
Temporal distribution	4
Priority for further research and conservation	Distribution

10.4 Common kingfisher (*Alcedo atthis*)

Short description

The Common kingfisher is a small kingfisher with seven subspecies recognized within its wide distribution across Eurasia and North Africa. It is resident in much of its range, but migrates from areas where rivers freeze in winter. In temperate regions, this kingfisher inhabits clear, slow-flowing streams and rivers, and lakes with well-vegetated banks. It frequents scrubs and bushes with overhanging branches close to shallow open water in which it hunts. In winter it is more coast-bound, often feeding in estuaries or harbors and along rocky seashores. *A. atthis* is highly territorial; since it must eat around 60% of its body weight each day, it is essential to have control of a suitable stretch of river. It is solitary for most of the year, roosting alone in heavy cover. Pairs form in the autumn but each bird retains a separate territory, generally at least 1 km (0.62 mi) long, but up to 3.5 km (2.2 mi) and territories are not merged until the spring (Fry et al., 1999). The nest is in a burrow excavated by both birds of the pair in a low vertical riverbank, or sometimes a quarry or other cutting. Both sexes incubate by day, but only the female at night. An incubating bird sits trance-like, facing the tunnel. The eggs hatch in 19–20 days, and the younglings stay in the nest for a further 24–25 days, often more. Once large enough, young birds will come to the burrow entrance to be fed. Two broods, sometimes three, may be reared in a season.

Relevance for the whole Adriatic Sea

This species has a widespread presence throughout Italy, especially in the North. The number of couples is estimated at 6000-16000 and abundance is considered stable (Brichetti & Fracasso 2007).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

Common kingfishers are important members of ecosystems and good indicators of freshwater community health. The highest densities of breeding birds are found in habitats with clear water, which permits optimal prey visibility, and trees or shrubs on the banks (Peris & Rodriguez, 1996). These habitats have also the highest quality of water, so the presence of this bird in the site confirms the standard of the water. It can tolerate a certain degree of urbanization, provided the water remains clean. No estimation is available specifically for the two Delta Po Natura 2000 sites, but for the wider region of Venice and Rovigo the number of couples is estimated to 600-900 (Mezzavilla et al., 2016).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	3
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	Since kingfishers are high up in the food chain, they are vulnerable to build-up of chemicals. River pollution by industrial and agricultural products excludes the birds from many stretches of otherwise suitable rivers that would be habitats.

10.5 Purple heron (*Ardea purpurea*)

Short description

A. purpurea is a wide-ranging species of wading bird in the heron family, Ardeidae. It breeds in Africa, central and southern Europe, and southern and eastern Asia. The Western Palearctic populations migrate between breeding and wintering habitats whereas the African and tropical-Asian populations are primarily sedentary, except for occasional dispersive movements. It is also a more evasive bird, favoring densely vegetated habitats near water, particularly reed beds (*Phragmites* sp.), and also visits mudflats, riverbanks, ditches and canals. It hunts for a range of prey including fish, rodents, frogs and insects, either stalking them or standing waiting in ambush. Purple herons are colonial but sometimes the nests are solitary. It sometimes associates with other species such as grey heron at multi-species nesting colonies. The site chosen is generally in reed beds, canebrakes or low bushes close to large lakes or other extensive wetlands. It builds a bulky nest out of dead reeds or sticks close to the water edge among reeds or in dense vegetation. About five bluish-green eggs are laid and are incubated by both birds. The young hatch about four weeks later and fledge six weeks after that; become independent at two months. They then disperse widely.

Relevance for the whole Adriatic Sea

In Veneto it is present for most of the year, usually not in winter (0-3 individuals). It nests mainly in the lagoons of the upper Adriatic and in the Delta Po. Estimated nesting population: 1800-2000 pairs in Italy (Brichetti & Fracasso, 2003), up to 300 pairs in recent years in Veneto (Mezzavilla et al., 2016).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

In recent years nesting colonies are mainly located in the province of Venice (the colony of Valle Dogà with 150 pairs is the largest of the approximately 30 in the Veneto region), Rovigo (Valle Morosina) and Verona (Palude del Busatello). The trend of the breeding population, after an increase between 1980 and the end of the last century, is gradually decreasing up to 30-40 pairs in this Site (Standard Data Form IT3270017).

In Delta del Po, small size of colonies, overall decline of abundance, and disappearance of habitat due to rice cultivation, call for the protection of this species.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	The presence of small colonies and the overall decline of the population highlight a poor state of conservation of the reeds, elective habitat for nesting, and the decrease of the surfaces cultivated with rice (Delta Po) used for feeding.

10.6 Squacco heron (*Ardeola ralloides*)

Short description

A. ralloides is a small bird in the heron family, Ardeidae. It breeds in southern Europe and in the Greater Middle East. It winters in Africa and it is rare north of his breeding range. It is a wading bird that frequents a wide variety of wetland habitats like ponds, lakes, slow flowing rivers, paddy fields but always with plenty of tree cover and emergent or floating vegetation where it hunts for a range of prey including fish, frogs and insects. Squacco herons are colonials with few pairs gathering (from two to ten) but always in wider groups with other species like grey heron, little egret, black-crowned night heron and great cormorant. They usually nest in the lower part of the colony on platforms of sticks or shrubs. The nesting period is from April to July when the pair lays between two and four eggs that hatch in about 22-24 days.

Relevance for the whole Adriatic Sea

There are 500-600 pairs estimated for Italy, most of which reproduce in the Po valley. The area of the Italian population is less than 20,000 km² (Boitani et al., 2002). The population has been overall stable over the past 15 years (Fasola et al., 2010). The wintering population in Italy is of 0-5 individuals (Brichetti P.& Fracasso G., 2003).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

The squacco heron is a summer nesting migratory species in the Po Valley. Most of the nesting takes place within the valley areas. No data is available specifically for Delta del Po, but in wider Veneto region the breeding population has been estimated to 50 pairs (Mezzavilla et al., 2016).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	3
Spatial distribution	1
Temporal distribution	2 (Apr, May, Jun, Jul, Aug, Sep)
Priority for further research and conservation	Implement monitoring of the breeding population on the site to investigate the causes of the small size of the breeding population. Some causes are: anthropic disturbance in the reproductive sites, the destruction and transformation of the nesting sites (mowing and burning of reeds, cutting of trees and shrubs and changes in the water level during the reproductive period), degradation and reduction of areas suitable for feeding due to the scarcity of prey and the rarefaction of aquatic plants caused by *Myocastor coypus* and water pollution.

10.7 Eurasian bittern (*Botaurus stellaris*)

Short description

B. Stellaris is a wading bird in the bittern subfamily (Botaurinae) of the heron family Ardeidae. It is widely spread across temperate Europe and Asia. Some populations are sedentary and stay in the same area throughout the year while northerly populations migrate southward toward Africa, the Arabian Peninsula, India and China. It is an extremely secretive bird that prefers to skulk in reed beds and thick vegetation near water bodies. It feeds on fish, small mammals, fledgling birds, amphibians, crustacean

and insects. In spring the mating call of the male can be heard at long distances. The nest it is usually built among reeds at the edge of bodies of water where the female takes care of the eggs. The younglings leave the nest in about two weeks and are fully fledged in another six weeks.

Relevance for the whole Adriatic Sea

Italian breeding population estimated at 50-70 pairs (70-100 male singers) and is considered fluctuating or stable at local level (Brichetti & Fracasso 2003, BirdLife International 2004). The wintering population in Italy is of 200-400 individuals (Brichetti & Fracasso, 2003).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

This species is regularly present at this site during wintering and irregularly during nesting. Between 2001 and 2010 in winter an average of 23 individuals were present in Veneto. The most frequented provinces are Venice, Rovigo and Verona (Mezzavilla et al., 2016); in general, 5-6 pairs can nest in the provinces of Rovigo and Venice.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	3
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	Habitat conservation, and in particular reeds, is the most important factor.

10.8 European nightjar (*Caprimulgus europaeus*)

Short description

The European nightjar is a crepuscular and nocturnal bird in the nightjar family that breeds across most of Europe and temperate Asia. All of the populations are migratory, and they winter in sub-Saharan Africa. The European nightjar prefers dry, open country with some trees and bushes such as heath, forest clearings and newly planted woodland. It hunts a wide variety of flying insects that catches mid-flight in the evening and night hours, while during the daytime it normally stays still on the ground or on a tree well camouflaged by his plumage. The breeding occurs between May and August. The males establish territories which they patrol and defend with a typical flight: wings in a V-shaped position and tail fanned. After the mating the female lays the eggs directly on the ground in a small hollow where they hatch after 16-18 days.

Relevance for the whole Adriatic Sea

Summer nesting migratory species throughout the Italian peninsula. The range of the species in Italy is vast (greater than 20000 km², Boitani et al. 2002). The Italian breeding population is estimated at approximately 10000-30000 pairs and is considered to be decreasing; occasionally present a wintering population (Brichetti & Fracasso 2006).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

No data is available specifically for Delta del Po. In Veneto, a breeding population has been estimated to 500-700 pairs (Mezzavilla et al., 2016).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	2
Temporal distribution	2 (Apri, May, Jun, Jul, Aug, Sep)
Priority for further research and conservation	Large-scale distribution investigations and density study have never been carried out. The main threats are the transformation of

	the nesting and feeding habitat, changes in the systems of agricultural management and cattle breeding.

10.9 Black tern (*Chlidonias niger*)

Short description

C. Niger is a small tern generally found in or near inland water in Europe and North America. Unlike other terns, it doesn't dive for food but forage on the wing, picking up small items in or near the water, or catching insects on the fly. It breeds in freshwater marshes across most of central and north Europe and North America, and it migrates south during winter to the northern shores of South America and Africa. Their nests are usually built on floating materials in a marsh or very close to water on the ground.

Relevance for the whole Adriatic Sea

The nesting range of the species in Italy is located in the western Po Valley (1383 Km², Boitani et al. 2002). The Italian population in 2004 was estimated at 240 mature individuals (Brichetti & Fracasso 2006) and is substantially stable (0 -25% compared to 240-320 individuals surveyed in 1984, Pulcher 1986).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

This is a summer nesting migratory species in the western Po Valley, especially in correspondence with rice fields. The most recent data estimate the presence of 120 couples. During the migrations (pre-reproductive migration between April and May and post-reproductive migration between July and October) the Venetian coasts and some inland wetlands are affected by a flow of individuals. Currently the species does not nest in the region.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	3
Spatial distribution	1
Temporal distribution	2 (Apr, May, Jun, Jul, Aug, Sep, Oct)
Priority for further research and conservation	Veneto still has large areas favorable to the transit and stopping of this species; more studies are needed.

10.10 Western marsh harrier (*Circus aeruginosus*)

Short description

C. Aeroginosus is a large harrier, a bird of prey from temperate and subtropical western Eurasia and Africa. This species has a wide breeding range from Europe to north-western Africa to Central Asia and the northern part of the Middle East. In Europe there are breeding areas in almost every country. Most populations are migratory or dispersive, wintering in sub-Sahara Africa or in the Indian sub-continent, while there are a few residents in the southern part of Europe. It is strongly associated with common reed (*Phragmites australis*) but can be found in a range of other open habitats, like farmlands and grasslands. It is a territorial bird during mating season, and also in winter it tends to stay isolated. It hunts slowly gliding over flat open ground and its preys are small mammals, small birds, insects, reptiles and amphibians. The breeding season varies from mid-March to early May. The male often pair with two and occasionally three females. The nest is built on the ground with sticks, reeds and grasses mostly inside reed beds where it lays a clutch of 3-8 eggs. The eggs hatch after 31-38 days and the chicks fledge after another 30-40 days.

Relevance for the whole Adriatic Sea

Widespread in the Po Valley: in Veneto 60-80 breeding pairs, 150-200 wintering individuals (Mezzavilla et al., 2016). The results of the IWC censuses in Veneto (period 2001-2010) indicate a modest decrease in trend (Wetlands International), with an annual variation of -5%; the average in 2006-2010 is 138 individuals. The number of mature individuals in the Italian population is estimated at 400-600 (BirdLife International 2004, Martelli & Rigacci 2005) and is increasing: in 2005 estimated 200-300 pairs (Martelli

& Rigacci 2005), previously estimated 170-220 pairs (Brichetti & Fracasso 2003). The wintering population in Italy is of 800-1000 individuals (Brichetti P.& Fracasso G., 2003).

Relevance for Natura 2000 site: Delta Po (IT3270017 and IT3270023)

Nesting areas are concentrated in the coastal wetlands of the Delta Po, the lagoons of Venice and Caorle. In the site 54 individuals are present during winter, while 20-30 pairs have been reported in the reproductive period (Standard Data Form IT3270017).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	The census activity of breeding pairs and individuals in migration is important. All this allows to know the trend of the presences at regional level, but also that at community level. In fact, recent surveys have shown that the trend has generally increased in Europe in the last 30 years but has instead declined slightly if we consider only the last ten years (PECBMS, 2011). This means that after a slight increase, the population is now stable or decreasing.

10.11 Hen harrier (*Circus cyaneus*)

Short description

The Hen harrier is a bird of prey widespread in most of the Eurasian continent. Part of the population is migratory, breeding in the north of Europe and in central-north Asia, moving south to the

Mediterranean, Middle East and southern China during winter. Another part is resident, wintering and breeding in the same area all year round, especially in central Europe and northern Italy and Spain. As a typical harrier, it prefers open land areas such as moorlands, bogs, prairies, marshes, grasslands where it hunts, slowly gliding at low altitude, mostly for small mammals and small birds. During mating season, one male mates with several females (up to five). The nest is built on the ground or on small mounds and it is made of sticks lined with grass and leaves. The clutch of eggs, four to eight, is incubated mostly by the female for up to 32 days. The chicks then fledge in about 36 days.

Relevance for the whole Adriatic Sea

It winters in a large part of the region but with a very low number of individuals and at the same time exhibits ample mobility; the annual rate is -0,3%. During the IWC censuses (period 2001-2010) in Veneto it was observed with an average of 50 individuals (Wetlands International 2020). It should be noted that the winter counts in the wetlands alone largely underestimate the presence of the species in the territory.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

The nesting of the species in Italy is irregular (0-1 pairs) (Brichetti & Fracasso 2003). In the site 13 individuals are present in the winter (Standard Data Form IT3270017).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	1
Temporal distribution	2 (Jan, Feb, Mar, Apr, Oct, Nov, Dec)
Priority for further research and conservation	In Italy, since *C. cyaneus* does not reproduce, the maintenance of the environmental types frequented in the wintering months should be resorted to.

10.12 Montagu's harrier (*Circus pygargus*)

Short description

C. pygargus is a bird of prey of the harrier family that can be found in most of Europe as a migratory or reproductive species, while it winters in sub-Sahara Africa. It is essentially a lowland bird that can be found on wetlands but prefers drier areas the like of heathlands, steppes, farmlands and grasslands. It hunts in the typical harrier fashion, gliding along fixed routes in a slow and low flight, catching a wide variety of small animals the like of rodents, reptiles and big insects. To breed, it requires a large open area with sufficient tall ground vegetation to provide cover without being overgrown. The nest is built on the ground so it is very susceptible to disturbances by mechanized agriculture since the breeding phase often coincides with the harvest period. Between May and June the female lays 3 to 5 eggs that are incubated for up to 35 days. The chicks leave the nest after 3 weeks, but are able to fly only when they are 35-40 days old.

Relevance for the whole Adriatic Sea

The reproductive area currently appears to be in a phase of slow regression. In recent years the species has disappeared from the nesting sites located inland in the province of Verona, Padua and Treviso, while a fair number of pairs still reproduce along the coastal area, close to the southern Venice Lagoon.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

Summer nesting migratory species. The nesting area includes the central regions and the Po Valley. In Veneto it is present in the periods of migration and subsequently in the reproductive phase. The most abundant population is the nesting population in the province of Rovigo, in the Delta Po. Overall, it is estimated that 30-40 pairs still reproduce in the Veneto (Mezzavilla, et al., 2016), of which about 10-17 in the Delta Po, with a trend towards a progressive decrease (All. B DGR 1728/2012). In 2005 the presence of about 27-48 couples was estimated (Mezzavilla & Scarton, 2005).

The practice of using rodenticides in many agricultural areas leads to secondary poisoning. This is still little studied in Italy and Veneto, but causes devastating effects on birds of prey. The *C. pygargus* feeds mainly on micro-mammals and its reproductive success depends on the abundance of this prey, so much so that the fluctuations of its population are often related to those of the prey and in particular to the presence of voles (Koks et al., 2007).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	1
Temporal distribution	2 (Apr, May, Jun, Jul, Aug, Sep)
Priority for further research and conservation	Investigation of threats (the practice of using rodenticides in many agricultural areas)

10.13 Great white egret (*Egretta alba*)

Short description

E. alba is a large egret with all-white plumage. It is generally a very successful species with a large and expanding range occurring worldwide in temperate and tropical habitats. It is a partially migrating species, with northern populations migrating to warmer areas during winter. During foraging *E. alba* usually stays alone, wandering mainly wetlands and inland water bodies with shallow water, but it often uses agricultural areas like croplands and the linked drains and channels. When hunting, it slowly stalks its preys or waits motionless until small mammals, amphibians, fish and sometimes reptiles or insects come to striking distance of his long bill. At night time dozens to hundreds herons gather on trees along medium to large rivers. It mainly mates in large mixed groups with other birds of the heron family close to lakes or other large wetlands. The male builds a large nest on trees where it attracts the female that lays up to six eggs. The pair then incubates the eggs for 23-26 days and feeds the chicks for another 6-7 weeks when they take flight.

Relevance for the whole Adriatic Sea

Since the 1990 it has expanded its range also in Italy, reproducing for the first time in some colonies of the southern Delta Po. Since then, it began to colonize a large part of the eastern Po Valley and in particular the wetlands along the course of the Po (Brichetti & Fracasso 2003).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

The species is a regular winter visitor and an irregular breeder at the Delta del Po site. In the years between 1998 and 2000, the investigation of nesting species in the colonies of the Veneto had confirmed the presence of an average of 6-7 breeding pairs in the provinces of Venice and Rovigo (Mezzavilla & Scarton, 2002). Recently, however, there has been a reduction in nesting pairs in Veneto; during the survey carried out between 2009 and 2010 was estimated the presence of just 1-2 pairs (Mezzavilla, et al., 2016). The resulting trend is a sharp decrease, with an annual variation of - 15%. On the other hand, the wintering population in the region is much more abundant: following the censuses carried out in the last ten years, wintering individuals are on average just over 1,400. The trend observed in 2001-2010 is stable, with a small annual decrease (-2%) (All. B DGR 1728/2012). In 2007, Veneto hosted about 15% of the wintering population in Italy.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	3
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	The low presence of breeding pairs requires a high level of protection and more studies on the factors limiting reproduction.

10.14 Little egret (*Egretta garzetta*)

Short description

The little egret is a small egret of the heron family. Its breeding range is temperate and tropical areas of Europe, Africa, Asia and Australia. The northern populations are migratory and move southward to warmer winters. In Europe its breeding range is gradually moving northward and westward after being extensively hunted during the 19th century. It lives in a wide variety of habitats, usually open grounds close to water bodies like marshes, wetlands, river and lakes shores, but can also be seen in coastal areas. It often uses rice fields and can be seen following cattle or other hoofed animals. They can be

often seen in small flocks, but they normally feed alone, stalking preys in shallow water, or using their feet to disturb small fishes and other animals or staying still in ambush. They sometimes feed on animals disturbed by grazing livestock or directly by eating parasites from their hide. Little egret nests in colonies, often with other herons. The nest is built on trees, shrubs or among reed beds, where the female lays three to five eggs. The pair takes care of the clutch of eggs for 21 to 25 days until they hatch, and then the chicks take another 40-45 days to fully fledge.

Relevance for the whole Adriatic Sea

Summer nesting migratory species in the Po Valley. Italian population estimated at 15,998 pairs in 2002 (Fasola et al. 2007), a significant increase since the 1970s which seems to have stabilized from 2000 onward (Fasola et al. 2010). In Veneto there are 900-1300 pairs (Mezzavilla et al., 2016); comparing the data of the census carried out between 1998 and 2000, equal to an average of 1.898 breeding pairs (Mezzavilla and Scarton, 2002) with those obtained in 2009-2010 which gave an average of 1109 pairs, it was possible to note a modest decrease, with an annual variation of -6%. A marked decrease was also observed between 2009 and 2010. The number of heronries were 35-39 in the same two-year period.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

The provinces most important for the nesting of the egret are Venice and Rovigo, including this site, where most of the wetlands of Veneto are located. The importance extends to wintering individuals, detected with the IWC censuses (ASFAVE data). The trend for the period between 2001 and 2010 was of modest decrease, with an annual variation of -5% (All. B DGR 1728/2012). The wintering population on the site is 619 individuals, while the reproductive population is between 600 and 700 pairs (Standard Data Form IT3270017).

The egret has shown a moderate decrease in Veneto in the last decade, while at European level the population trend is increasing slightly. The causes of the decrease in the nesting population in Veneto are not fully known but could be related above all to the disturbance breeding sites and the increase in the gray heron which in many cases competes for breeding sites and in part for the supply of trophic resources.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	For the conservation of the egret, the reproductive sites should be better protected, reducing the degree of disturbance.

10.15 Black winged stilt (*Himantopus himantopus*)

Short description

H. himantopus is a very long-legged wader in the Recurvirostridae family. It is a widespread stilt common in Eurasia and Africa, a resident in the warmer climates while populations living in cold climates migrate during winter to coastal regions. Its preferred habitats are marshes, shallow lakes and ponds, lagoons, anthropic habitats like rice fields and salt flats where it hunts in the mud or sand for insects and crustaceans with the long and slender bill. It breeds on the shores of lagoons and salt marshes, either building a nest with sticks and grasses or digging a shallow hollow in the sad or dirt. The nests are often built in colonies, sometimes together with other birds like pied avocet, terns, and redshank. Between April and June 3-4 eggs are laid that hatch after 25-26 days. Both the male and the female take care of the chicks that are fully fledged in about one month.

Relevance for the whole Adriatic Sea

Italian breeding population estimated at 3000-4000 pairs and is increasing (BirdLife International 2004, Brichetti & Fracasso 2004); of which therefore a significant fraction would reproduce in the Veneto. In winter >200 individuals are present.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

The breeding population appears concentrated in the provinces of Venice and Rovigo, including this site, with less presence in Verona. In Venice, around 500 pairs were estimated in 2002 (Scarton et al., 2005), a value to be considered as a minimum also for more recent years. In some nesting sites, the species has shown a moderate increase in recent years; detailed censuses conducted in the Venice lagoon on almost 100 reconstructed sandbanks showed an annual increase in the population of 17%, between 2005 and 2011 (Scarton et al., 2009). For the province of Rovigo, 93 to 143 pairs are estimated in 2004 (Verza, 2004), more recently 150-200 (Verza, pers. comm.). The regional population was estimated at 700-800 pairs (Mezzavilla et al., 2016). The reproductive population on Site is between 100 and 120 pairs (Standard Data Form IT3270017).

There is an absence of coordinated censuses at the regional level, which are necessary for this and other species of conservation interest. The very few colonies located on the barrier islands are generally threatened by the presence of tourist and only specific management interventions can reduce the disturbance. The creation of new wetlands of fresh water, provided that they are equipped with suitable islands for nesting, offers interesting prospects for the spread of the species even beyond traditional nesting areas.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	1
Spatial distribution	1
Temporal distribution	2 (Apr, May, Jun, Jul, Aug, Sep)
Priority for further research and conservation	Threats by the tourism at the barrier islands

10.16 Little bittern (*Ixobrychus minutus*)

Short description

I. minutus is a small wading bird in the heron family. It is a Eurasian and African bird, breeding in central and southern Europe, west and southern Asia and Africa. Populations of temperate Europe and Asia migrate southward during winter, while tropical populations are residents. The little bittern is a crepuscular bird normally solitary. It hunts slowly stalking its preys among reed beds looking for insects,

fish and amphibians. During mating season, it builds a nest among large enough flooded reed beds to offer complete cover and protection from predators. Eggs are laid from the middle of May and there is normally only one brood of 5-6 chicks. The eggs take 17-19 days to hatch and the younglings are fledged after 25-30 days.

Relevance for the whole Adriatic Sea

Italian population estimated at 1300-2300 pairs (Brichetti & Fracasso, 2003) and is stable in the period 1990-2000 (BirdLife International 2004). However, the species now appears to be in decline, suspected of being at least 10% in the last 10 years (about 3 times), especially in the Po Valley. Occasionally present during winter.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

In Italy a large part of the breeding population is concentrated in the Po Valley, including this site. In Veneto it nests mainly in the lagoon coastal areas between the Delta del Po and the river of Tagliamento. However, it seems that in the last decade some areas have been gradually abandoned due to the ongoing environmental changes. A very conservative estimate made in 2005 allowed to extrapolate the presence of about 330-645 breeding pairs. Of these, the largest numbers are concentrated in the provinces of Venice and Rovigo where the largest extensions of wetlands are present (Mezzavilla et al., 2016), making this an important site for the conservation of this species.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	1
Temporal distribution	2 (Mar, Apr, May, Jun, Jul, Aug, Sep, Oct)
Priority for further research and conservation	Currently its status at regional level is not well known, because specific research in the areas of settlement is lacking.

10.17 Black crowned night heron (*Nycticorax nycticorax*)

Short description

It is a medium-size heron that can be found around the world except in the coldest areas and in Australasia. It is a migratory bird in its northern populations, while it is a resident in the rest of his range, even in cold regions of South America. It is closely related to fresh and salt-water wetlands, where it hunts during the night and early morning standing still at the edge of the water, waiting for big insects, fish, crustaceans and amphibians. It adapts also to anthropic habitats the like of rice fields, drains, old flooded mines. During daytime tends to be a gregarious bird, resting on hygrophilous trees like willows or poplars in big groups. The nest it is built among colonies with other herons like grey herons and little egrets. The night heron lay eggs between April and July, three to five of them, which are then incubated for about 25 days.

Relevance for the whole Adriatic Sea

Italian population estimated at 13667 pairs in 2002 (Fasola et al. 2007). The species in northern Italy had a decline of almost 50% from 1995 to 2006. After an increase that occurred until 1989, the population decreased to the levels of the 1970. The situation seems to have stabilized in recent years (Fasola et al. 2010).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

At this site, as well as in the rest of Veneto region, this species is breeding, migratory and in the least part wintering. Most of the nesting sites fall within the coastal area and are included in the provinces of Venice and Rovigo. The number of colonies ranges from 28 in 2009 to 30 in 2010. From the analysis of the data collected, a decrease of 3% per annum was found; ranges from an average of 581 pairs for the 1998-2000 three-year period, to 346 in 2001-2002, to about 388-443 in 2009-2010. All this data compared to the data of the 1980, when only 230 breeding pairs were estimated in the island of S. Cristina in Quinto (Mezzavilla and Scarton, 2002), confirms a moderate decrease at the regional level. The trend of winterers, for the period 2001-2010, can be classified as uncertain, with an annual rate of +10%. During the 2006-2010 period in the Veneto, the wintering population is, on the average, made by 160 individuals (Mezzavilla et al., 2016), of which the wintering population on Site is of 111 individuals (Standard Data Form IT3270017).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	The protection and management of both nesting sites and those used for stopping during the winter are some of the most important factors to ensure the presence of *N. nycticorax* in the site.

10.18 Pigmy cormorant (*Phalacrocorax pygmeus*)

Short description

The pigmy cormorant's range goes from Easter Italy to the Balkan countries, Greece, Turkey, South-East Asia and the area of the Tigris-Euphrates river system. Most of the world population is focused in Europe, particularly in the Danube river delta. It is a great fish-consumer that prefers river deltas, pools and lakes with plenty of vegetation and generally freshwater habitats, but can be found also in brackish areas. They normally rest between hunts and during nights in roosting sites together with other cormorants and egrets, sometimes in large gathering of hundreds of birds. The breeding period is between April and May often in and among heronries with other cormorants and herons where they build a nest from sticks and reeds. Both parents incubate the clutch of eggs up to a month, and nestlings become independent after 70 days.

Relevance for the whole Adriatic Sea

The species is of recent colonization in Italy and currently nests in four sites (Brichetti & Fracasso, 2003). Since 1990 nesting has been recorded in the Venice Lagoon and new breeding sites are in the Lagoon of Caorle and in the Delta Po. Even as a winter visitor, the population of this species has increased since the 1990s (Serra et al., 2000; Baccetti et al., 2002); the most recent estimate is 2306 individuals (2007, ISPRA data), concentrated mainly in the upper Adriatic coasts. Also, in Veneto the population of *P.*

pygmeus showed a significant increase (35%). The average for the five-year period 2006-2010 is 1500 wintering individuals, with a maximum of 2091 individuals in 2008 (Mezzavilla et al., 2016).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

This site is one of the five macrozone identified as being of national importance for *P. pygmeus,* with the wintering population on this site estimated at 131 individuals (Standard Data Form IT3270017). The most recent national estimate (2001) is 118-128 pairs (Brichetti and Fracasso, 2003), whereas the later study, focusing on Veneto region only, estimated 564-589 couples at 6 sites in 2010 (ASFAVE, ined.). In 2007 the overwintering regional population represented 69% of the Italian one.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	1
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	The disturbing activities by the cormorant at the nesting sites of *P. pygmeus* must be carefully evaluated: the co-presence of the two species was the probable cause of the abandonment of the Val Dogà breeding site in the spring of 1999 (Bon et al., 2000).

10.19 Ruff (*Philomachus pugnax*)

Short description

The Ruff is a medium-size wading bird of the sandpiper family. It is a gregarious migratory bird that breeds in the northernmost part of Europe and Asia and winters mostly in Africa, southern Asia and Australia. When not breeding, the birds use a variety of shallow wetlands either natural or anthropogenic. It feeds mainly on insects and crustaceans but during migration can vary its diet depending on the availability, adding small plant material and cereals like rice. During mating season, it becomes more habitat-selective, looking for extensive lowland freshwater marshes, damp grasslands

and shallow deltas. The wetter parts provide feeding grounds, while dryer areas among the moderately tall grass are used by the females to build a nest. The eggs, laid between mid-March and July, and the chicks are taken care of only by the female until they fledge 25-28 days after hatching.

Relevance for the whole Adriatic Sea

During the migratory stops it seems to use mainly coastal environments in the Veneto (fishing valleys in particular) and to a lesser extent inland wetlands. Outside of the winter censuses, the species is only occasionally observed, always with few individuals.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

At this site, the species is generally observed in groups that reach 20-30 individuals during pre-reproductive migration, but much more substantial aggregations are also known, up to about 3000 individuals in Delta Po (Mezzavilla et al., 2016). Wintering is very rare in the region, as in most of Italy. During the IWC censuses of 2001-2010, the species was observed only on a few occasions and not in all years, limited to the provinces of Venice and Rovigo, including this site.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	2
Temporal distribution	2 (Feb, Mar, Apr, May, Aug, Sep)
Priority for further research and conservation	The species quickly uses the water bodies of artificial origin; environmental intervents often carried out for hunting purposes, has locally allowed new populations of *P. pugnax* to settle in Italy, which in a few years have reached levels of national importance.

10.20 Greater flamingo (*Phoenicopterus roseus*)

Short description

P. roseus is the largest and most widespread of the flamingos, found in Africa, Indian subcontinent and southern Europe. The greater flamingo has a complex ecology that contemplates partial migrations, vagrancy and juvenile dispersion. Also established colonies are often highly mobile in relation to trophic availability. It lives on mudflats and shallow coastal lakes, filtering through their bill the mud that they stir with their feet looking for insects, crustaceans, mollusks and other small food items. At the end of winter, it builds a nest in a flooded area, creating a mud mound where it lays a single egg from the end of March.

Relevance for the whole Adriatic Sea

In the Mediterranean basin the environments suitable for the greater flamingo are represented by coastal wetlands with low disturbed waters: deltas, lagoons and salt marshes; colonial and post-reproductive gatherings are concentrated in these environments. In 2008 the first nesting was documented in the upper lagoon of Venice (Baccetti et al., 2008), and in 2013 the second nesting nearby (Mezzavilla et al., 2016). Isolated specimens or small groups are observed sporadically in Verona, Belluno and coastal areas of eastern Veneto.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

Numerous groups of flamingos, some made up of thousands of individuals, both adults and juveniles, are regularly recorded in Delta del Po since 1998. In winter, during IWC censuses of 2001-2010 in provinces of Venezia, Verona and Rovigo, including Delta del Po, the species showed a strong increase in the regional territory, and in 2015 about 7000 individuals wintered (Mezzavilla et al., 2016). Although with evident interannual fluctuations, the annual growth rate is 40% (All. B DGR 1728/2012). The wintering population on Site is 187 individuals (Standard Data Form IT3270017).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	1
Spatial distribution	2

Temporal distribution	2 (Feb, Mar, Apr, Aug, Sep, Oct, Nov)
Priority for further research and conservation	Locally it has increased its presence in the last decade, stabilizing its presence and even nesting. Failure to nest and damage to young people and adults resulted from adverse weather conditions. Possible threats are given by direct and indirect anthropic disturbance (shellfish farming).

10.21 European golden plover (*Pluvialis apricaria*)

Short description

P. apricaria is a relatively large plover ranged from northern Asia to southern Europe and northern Africa. It is a migratory bird that breeds in the Arctic tundra and other Palearctic regions while winters in central and southern Europe on open areas like arable fields, meadows, mudflats.

Relevance for the whole Adriatic Sea

This species is mainly distributed in the Venice lagoon, to a much lesser extent in the Delta Po. The ten-year trend, although with a significant average annual increase, is uncertain (All. B DGR 1728/2012).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

This species is observed in Veneto region, including this site, mainly during wintering and migrations. The available data for this species are scarce. Its presence in lagoon environments subject to the tidal excursion is generally low, while in agricultural environments it is sometimes observable in significant concentrations: 660 individuals in Bonifica della Donzella (Delta del Po, February 2003; ASFAVE, 2004) or 580 individuals at Ca 'Pasta (ASFAVE, 2009) and 1168 individuals between Bonifica Donzella and Bacucco (ASFAVE, 2010). The wintering population on Site is 60 individuals (Standard Data Form IT3270017).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	2
Temporal distribution	2 (Feb, Mar, Sep, Oct, Nov)
Priority for further research and conservation	The reduction of agricultural land in favor of buildings leads to a decrease in possible winter feeding areas. The species regularly frequents wet meadows restored with community agri-environmental measures that should be encouraged.

10.22 Pied avocet (*Recurvirostra avosetta*)

Short description

The pied avocet is the Eurasian and African avocet vastly widespread along the coastal regions and central Asia. It is mainly a migratory bird, breeding in western and central Asia and wintering mainly in Africa, but several populations are resident in the mildest part of their range. It is a wading bird that prefers mudflats, salt flats and lagoons but sometimes wander on freshwater habitats. It eats small invertebrates, plant material and seeds that float in shallow water. The preferred breeding habitat are salt flats, sandy islands in lagoons and other similar coastal areas where it gathers in colonies, often together with other plovers and stilts. During the nesting period, it lays between 3 and 5 eggs from April to July that are incubated around 25 days. Sometimes two females lay their eggs in the same nest.

Relevance for the whole Adriatic Sea

In the region, the pied avocet frequents exclusively the coast, with much rarer presences in more inland wetlands. IWC census registered about 3000 individuals in period 2006-2010, with some macrozones that assume national importance for the wintering of the species. The trend observed in 2001-2010 is stable, albeit with a modest annual decrease of -2%. In this period the avocet is found both in the fishing valleys, with a maximum of about 1500 individuals in January in a single site in the Delta Po, and in the open lagoons, in the pockets and in the benches. Even in the absence of updated data for the whole of

Italy (last estimate: 1800-2000 pairs, Brichetti &Fracasso 2004) it can be reasonably believed that the Venetian coastal arch constitutes one of the most important Italian reproductive sites for this species.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

The breeding population is concentrated in the coastal areas of the provinces of Venice and Rovigo; it is possible to estimate 800-900 pairs (Mezzavilla et al., 2016) with a significant increase compared to what was known for the early 2000s (just over 100 pairs: Scarton et al., 2005). In the nearby Lagoon of Venice, increases of 24% per year were observed in the period from 2005 to 2011. The species may show fluctuations, even substantial from one year to the next. The breeding population on Site is from 100 to 200 pairs (Standard Data Form IT3270017).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	3
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	Maintenance operations of the channels inside the valleys should be promoted to ensure the continuous availability of islets without vegetation, which prove to be optimal for this and other species.

10.23 Little tern (*Sterna albifrons*)

Short description

The little tern is a small Eurasian tern that breeds along the coast and inland waterways of temperate and tropical Europe and Asia. It is a migratory bird, wintering as far south as South Africa and Australia. It's a strictly ichthyophagous species that searches for small fishes along the shores and dives to catch them. It nests in colonies that count from dozens up to hundreds of pairs, nesting directly on sand, dirt

or pebbles on the beaches and on lagoon or delta islands. It can sometimes nest inland along large rivers if there are sandy or pebbly shores available.

Relevance for the whole Adriatic Sea

The Italian population is mainly concentrated in the Po Valley, coastal areas of the northern Adriatic and Puglia, Sicily and Sardinia. The national population is estimated at 2000-3500 pairs (Brichetti & Fracasso, 2006). Considering the presence of other small nuclei, the regional population is 1200-1700 pairs (Mezzavilla et al., 2016); this figure, although indicative, assumes particular relevance when compared with the estimate available for all of Italy (All. B DGR 1728/2012).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

In Veneto, the species is mainly concentrated in the coastal area, with fewer presences along riverbanks and in large lakes. In the last twenty years, cases of winter presence have been very rare. The nesting nuclei are concentrated in Delta del Po and wider Veneto region. The size of the nesting population is well known for the province of Rovigo, thanks to annual censuses of all possible nesting sites, and they are equal to 800-900 pairs per year (2009-2010; Verza, pers. comm.). The breeding population in the Venice Lagoon and Delta del Po doubled between 2000 and 2010, going from 700-800 to 1300-1600 pairs (Scarton et al., 2005). The breeding population on Site is from 250 to 300 pairs (Standard Data Form IT3270017).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	1
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	Given the importance of the population of Veneto on a national scale, this species deserves detailed monitoring and above all consequent conservation measures.

10.24 Common tern (*Sterna hirundo*)

Short description

The common tern is a circumpolar tern that breeds in temperate and subarctic regions of Europe, Asia and North America. It is strongly migratory, wintering along the coast of tropical and subtropical areas around the world. It is mainly a coastal inhabitant, thus feeding on fishes by plunge-diving. It breeds in colonies on any flat and poorly vegetated area along the coast, although can sometimes nest in gravel beds along inland water bodies and large rivers or can adapt to man-made habitats the like of abandoned wharf. The nest is built directly on the ground and it consists of a shallow hollow, often lined with any debris or plant material available. Pairs are usually stable from one season to the next, and the nest it is usually re-used. The 3-4 eggs are laid between the end of April and July, incubated by both parents for about 20 days. The pair takes care of the younglings until they fledge and they keep feeding them even during part of the migratory flight.

Relevance for the whole Adriatic Sea

The breeding populations in Italy are concentrated in the Po Valley, along some of the main rivers and in some coastal areas of central Italy and Sardinia. For the whole country, 4000-5000 pairs are estimated.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

The common tern is regularly present in Veneto region during migrations both along the coastal arc (Delta del Po, Venice and Caorle lagoons, coasts) and in nearby freshwater wetlands. Overall, 1800-2000 pairs can be estimated in Veneto, which could represent 30-40% of the national total. In the province of Rovigo, including Delta del Po, 900-1000 pairs nested in 2007-2010, concentrated in the fishing valleys, and in province of Venice 800-1000 pairs can be estimated (Mezzavilla et al., 2016). A detailed monitoring carried out in the open lagoon of Venice since 1989 has shown a progressive drop in the breeding pairs in the sandbanks, probably to be related to the increase in high tide and storm surges in the central nesting period (Scarton, 2010). The breeding population on Site is from 100 to 200 pairs (Standard Data Form IT3270017).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	1
Temporal distribution	2 (Apr, May, Sep, Oct)
Priority for further research and conservation	So far, if not absent, the management measures adopted to encourage the reproduction of the species in freshwater basins, which instead should be implemented vigorously to diversify and increase the number of reproductive sites.

10.25 Sandwich tern (*Sterna sandvicensis*)

Short description

S. sandvicensis is a medium-large tern that has a worldwide distribution. It's a migratory bird, a visitor of mainly northern Europe during summer while it winters in tropical and subtropical Africa and South America. It has a strictly fish-based diet hunting out to sea and in deep brackish waters, plunge-diving to catch medium to small preys. Nesting preferred sites are barrier islands and sandbars along the coast, where it gathers in large colonies built directly on sand or gravel. Often other birds join the colony to take advantage of the protection provided by the sandwich tern, like common tern, little tern and redshank. It lays eggs in May-June and the pair keeps feeding the chicks even after complete fledge and during part of the migratory flight.

Relevance for the whole Adriatic Sea

The Italian breeding populations are concentrated in the Venice lagoon, the Delta Po of Emilia, some Apulian wetlands; 800-1300 couples were present in the early 2000s. Even in the absence of recent national estimates, it is conceivable that Veneto every year hosts at least half of the Italian breeding population of this species.

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

Delta del Po, together with other coastal parts of Veneto, represents an important part of migration route for the sandwich tern. Nesting has been confirmed in Veneto since 1995, when about 200 pairs settled in a sandbank in the southern lagoon of Venice (Scarton & Valle, 1996). Subsequently the species showed a progressive increase, albeit with evident annual fluctuations. In recent years (2014-2015), the breeding population has averaged around 1500 pairs (Mezzavilla et al., 2016). In the province of Rovigo, including the Delta del Po site, nesting is only considered possible or probable (Verza, com pers.); there are no other reports for the remaining Veneto provinces. The breeding population on Site is from 1 to 8 pairs (Standard Data Form IT3270017).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	2
Temporal distribution	2 (Mar, Apr, Sep, Oct, Nov)
Priority for further research and conservation	Given the absolute specificity of the nesting sites, the possibilities of management interventions will concern the few sandbanks used, protecting them from erosion and availability, where necessary, modest heaps of fragments of shells where the *S.sandvicensis* can build their nest.

10.26 Kentish plover (*Charadrius alexandrinus*)

Short description

C. alexandrinus is a small shorebird that can be found in most of Africa, Asia and Europe on the shores of saline lakes, lagoons and generally sandy habitats close to water. It is generally a resident species, living all year round in the same area, although some northern populations migrate during winter to warmer climates. It is an insectivorous species, catching small invertebrates on the shoreline and moist terrain,

mostly individually but can incorporate into loose flocks, both mono- and pluri-specific. It breeds mainly on sandy or pebbly shores, laying eggs in shallow scrapes directly on the ground lined with debris and every small item that can be found in the vicinity. The pair defends the territory around the nest or use distraction tactics when predators come close to the eggs or chicks. Eggs are laid between April and June and incubated by both parents for 20-25 days.

Relevance for the whole Adriatic Sea

Wintering and breeding populations throughout the Peninsula. The Italian breeding population is estimated at approximately 1300-2000 pairs and is considered to be consistently decreasing; the wintering population is estimated between 2300 and 3300 individuals (Brichetti & Fracasso 2004).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

In Veneto a breeding population has been estimated to be less than 150 pairs, with an average wintering population of 92 individuals, all of them in Venice and Rovigo provinces (Mezzavilla et al., 2016). It is estimated that 10 to 50 pairs reproduce within the Delta del Po Natura 2000 area. On the average 37 individuals use this area as wintering grounds (Standard Data Form IT3270023).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	2
Temporal distribution	1
Priority for further research and conservation	Evaluating of ongoing protection efforts and development of further regulations to lower impacts on the reproductive sites. The main threat is the anthropic pression on beaches, elective reproductive sites of the species, while should be futher researched the impact of predation on nests and chicks.

10.27 Red-backed shrike (*Lanius collurio*)

Short description

The red-backed shrike is a carnivorous passerine bird that breeds in Western Europe and Central Russia, while during winter it migrates to tropical Africa. It is a solitary and territorial bird that spends much of his time perched atop trees, bushes or poles both to control their territory for intruders and to look for preys. It mainly hunts invertebrates but can seize larger animals the like of small mammals, birds and reptiles. The way in which it stores excess food by impaling it on thorns is distinctive of all shrikes. His preferred habitats are dry grasslands with few trees and bushes. *L. collurio* is a monogamous bird that tends to occupy the same breeding territory year after year where the pair builds a deep nest among bushes at low height, using sticks and other plant material. The female lay 3-6 eggs between May and July that are incubated only by the female while the male provides food. The chicks are able to fly around 20 days after hatching and become independent at the age of one month.

Relevance for the whole Adriatic Sea

Breeding Italian population is estimated in 20000-60000 (Brichetti & Fracasso, 2011) pairs with a strong decrease between 2000 and 2014 (-53%) (LIPU & Rete Rurale Nazionale 2011, www.mito2000.it).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

No data is available for Delta del Po only. In the wider Veneto region, a population of 2000-3500 pairs was estimated (Mezzavilla & Scarton, 2005), with a strong decrease was in recent years (Mezzavilla et al., 2016).

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	2
Spatial distribution	2
Temporal distribution	2 (May, Jun, Jul, Aug, Sep)
Priority for further research and conservation	Confirmation of pair numbers reproducing

	on site and therefore trending should be assessed. Impact of agricultural practices like use of pesticides and clearing of hedgerows habitats should be better studied. The efficiency of environmental restoration of these traditional agricultural practices should be studied also.

10.28 Lesser grey shrike (*Lanius minor*)

Short description

L. minor is a small migratory shrike that breeds in southern and Western Europe and eastern Asia while it winters in southern Africa. As the other passerine in the shrike family it hunts from prominent perches, catching mainly large insects that sometimes impale on thorns and barbed wire to use as a "larder". In summer it inhabits open areas the like of heathland, farmland and other natural or anthropic habitats, mostly dry and with isolated bushes and trees. During winter it is mainly found in scrublands and among thorn trees. It mainly builds its nest on isolated trees where the pair uses sticks and other plant material lined with softer elements the like of wool, hairs and feathers. The breeding period is between May to early June, when 5 to seven eggs are laid and incubated mainly by the female for around fifteen days. The chicks are then fed by both parents and are ready to leave the nest in about two weeks.

Relevance for the whole Adriatic Sea

Migratory bird breeding in Italy. There are 1000-2000 pairs breeding in the whole Italy (Brichetti P., Fracasso G., 2011 - Volume 7). The Italian population is thought to be strongly decreasing with a recorded decrease of 80% between 2000-2010 (LIPU & Rete Rurale Nazionale 2011, www.mito2000.it).

Relevance for Natura 2000 site: Delta del Po (IT3270017 and IT3270023)

There are 2-3 pairs reported breeding on site. No data are available on regional distribution and population (Standard Data Form IT3270023).

Assessment of the species at this site

Existing knowledge about this species at this site	3
Abundance	4
Spatial distribution	3 (Rare)
Temporal distribution	2 (Apr, May, Jun, Jul, Aug, Sep)
Priority for further research and conservation	Confirmation of pairs number reproducing on site and therefore actual presence and trending should be assessed. Availability of suitable breeding habitats should also be checked and evaluated. Assessing of pesticide impacts on the suitable breeding habitats should be better studied.

11. MAMMALS

11.1 Common bottlenose dolphin (*Tursiops truncatus*)

Short description

The common bottlenose dolphin (hereafter bottlenose dolphin) is a globally distributed species, absent only from polar regions. The adults can reach up to 3.8 m in length and 400 kg. The color on the back and flanks is dark grey, with a gradual transition towards almost white ventral side. The species is characterized by long life span (40 to 50 years on average) and low reproductive rate. In climates with notable seasonal temperature variations females tend to give birth during the warm months. The calves remain with mother for 3 to 5 years. The bottlenose dolphins are highly adaptable to prey availability and some populations are known for unique foraging techniques.

Relevance for the whole Adriatic Sea

The bottlenose dolphin is the only cetacean species regularly inhabiting the northern and central Adriatic Sea. Historical records indicate that the Adriatic population of this species declined by 50% in the second half of 20th century, owing primarily to the ongoing extermination campaign and further helped by habitat degradation and prey depletion (Bearzi et al. 2009).

Even though the species appears to be present throughout the basin, the genetic study of Gaspari et al. (2013) suggests that Adriatic population cannot be regarded as a single stock. Genetic differentiation was found between northern and central-south portions of the Adriatic, and between east and west sides of the basin. Furthermore, there seems to be a relatively high level of gene flow from northern Adriatic to adjacent areas, with females acting as primary gene flow mediators.

Boat-based photo-identification studies conducted in several locations in the Adriatic corroborate the population structuring into putative local sub-populations, as indicated by the genetic study. For instance, comparison of dorsal fin reference catalogs between Gulf of Trieste and Kvarnerić found no matches (Genov et al. 2009). Furthermore, no matches were found between catalogs from Croatian coastal areas and those from Montenegro, Albania, and Italy. Recent work by Pleslić et al. (2019) describes at least three socially and spatially distinct local sub-populations along a 300 km stretch between Istrian peninsula and Vis archipelago. This study found the local sub-populations to be in

limited contact through movements of few individuals between them, but with a notable influx of transient individuals visiting the coastal areas from the offshore part of the Adriatic.

The aerial surveys conducted in 2010 and 2013 reveal for the whole Adriatic Sea a surface density of 0.042 individuals/km^2 and abundance estimated at 5700 individuals (95% CI = 4300-7600) (Fortuna et al. 2018). This study identified three areas within the Adriatic with surface densities higher than the average: the northern Adriatic, the Jabuka pit and the southern Adriatic.

Relevance for Natura 2000 site: Cres-Lošinj (HR3000161)

Studies on biology and ecology of the bottlenose dolphins in this area started in 1987 and have been ongoing since that year. A considerable body of literature on bottlenose dolphins' biology and ecology in this Natura 2000 site is available.

Abundance

Up until 1997 Bearzi et al. (1997) indetified 107 individuals and noted their long-term residency in the area. The abundance estimates for the period from 1995 to 2003 indicated a 39% decline, from 168 individuals (95% CI = 132-229) to 102 individuals (95% CI = 86-127) (Fortuna 2006). Later study showed a recovery of the local sub-population for the preiod from 2004 to 2011, with estimates varying between 112 (95% CI = 94-150) and 310 individuals (95% CI = 265-329) (Pleslić et al. 2013). The interannual variations were attributed to shifts in habitat use, rather than actual changes in abundance. The latest abundance estimates (see Annex 1 for Materials and Methods) for the period from 2014 to 2018 vary from 131 (95% CI = 123-149) to 224 individuals (95% CI = 215-243).

Distribution

Pleslić et al. (2019) estimated the home range of the Cres-Lošinj bottlenose dolphin sub-population at 2121 km^2. The Cres-Lošinj Natura 2000 site, with a surface of 525 km^2, covers approximately 25% of their home range. Rako-Gospić et al. (2017) found that the home range hub area, e.g. where home ranges of the most resident individuals overlap, lies completely within this Natura 2000 site, indicating its importance.

However, the distribution of bottlenose dolphins within this site was found to be changing seasonally due to anthropogenic factors. The study of Rako et al. (2013) found a negative correlation between the intensity of underwater noise caused primarily by leisure boating and dolphin encounter rate and total number of dolphins within the study area. This effect was pronounced during the summer months when

the leisure boat traffic is most intense. Furthermore, Rako et al. (2017) found increase in home range areas for both females and males during the summer, further corroborating the avoidance of the areas closer to the coast where the boat traffic is more intense.

Behaviour

The study on effects of physical presence of vessels on behavioral budget of bottlenose dolphins within the Cres-Lošinj Natura 2000 site revealed negative interactions, e.g., avoidance of vessels, occurring depending primarily on type, number and proximity of vessels (Nimak 2006). The dolphins were found to decrease proportion of time spent in foraging related activities in presence of boats, indicating that excessive exposure to boat traffic can lead to negative energetic balance.

Furthermore, the underwater noise was found to cause changes in the vocalization of the bottlenose dolphins, which used longer whistles at higher frequencies particularly during foraging and socializing activities (Rako et al. 2015).

The Cres-Lošinj Natura 2000 site is also an important nursing area for bottlenose dolphins. Newborns are regularly observed here. Furthermore, natal philopatry was noted indicating the importance of the area for all life stages.

Assessment of the species at this site

Existing knowledge about this species at this site	5
Abundance	3
Spatial distribution	3 (generally present throughout the site, but with seasonal variations in density)
Temporal distribution	1
Priority for further research and conservation	Genetics, toxicology

Relevance for Natura 2000 site: Vis (HR3000469)

The research on bottlenose dolphins in the wider area around the island of Vis started in 2007 and has been conducted in summer months since.

This relatively open area hosts a mixture of a resident sub-population exhibiting long-term site fidelity and transient bottlenose dolphin individuals. Approximately 25% of individuals encountered here can be

considered as regularly using the area (Pleslić et al. 2019). These form a socially distinct community with a home range centered around the island of Vis. The Vis Natura 2000 site lies completely within and covers 45% of their home range (Pleslić et al. 2019).

In the period from 2008 to 2010 the abundance estimates for a 7400 km^2 area surrounding the island of Vis, and including this Natura 2000 site, varied from 371 (95% CI = 325-442) to 474 individuals (95% CI = 352-683) (Holcer 2012). The area-based abundance estimated specifically for this site range between 145 (95% CI = 106-245) individuals in 2014 and 261 (95% CI = 239-302) individuals in 2018 (see Annex 1 for Materials and Methods).

The presence of females with newborns and calves indicates the importance of this site for all life stages. The calving season peaks in July and August with a notable 2-year cycle. Female fertility rate was estimated at 0.14.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	3
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	Interactions with fisheries, genetics

Relevance for Natura 2000 site: Trezze San Pietro e Bardelli (IT3330009) and Tegnùe di Chioggia (IT3250047)

No dedicated research aimed specifically at these sites exists. Furthermore, the two sites are ecologically similar. Therefore, the overview of the existing knowledge is given for both sites here.

Based on data from aerial survey conducted in summer seasons of 2010 and 2013, the northern Adriatic, including the Natura 2000 sites Trezze San Pietro e Bardelli (IT3330009) and Tegnùe di Chioggia (IT3250047), hosts the highest density of bottlenose dolphins in the Adriatic: 0.057 individuals/km^2 (Fortuna et al. 2018). The same study estimated the abundance for the northern Adriatic at 2600 individuals (95% CI = 2200-2900). However, these estimates are not corrected for availability bias, hence they are underestimates. Given the wide-ranging nature of the species and the small size of these two

Natura 2000 sites, they probably represent only a small proportion of the habitat of the bottlenose dolphins in the Adriatic Sea.

Assessment of the species at this site

Existing knowledge about this species at this site	4
Abundance	4
Spatial distribution	1
Temporal distribution	1
Priority for further research and conservation	Habitat use, anthropogenic threats

12. CONCLUSIONS

This review presents knowledge on 48 species in six Natura 2000 sites in the Adriatic Sea. Of these 48 species, 42 are listed as Target Species in the Standard Data Forms for the selected Natura 2000 sites (available at http://natura2000.eea.europa.eu/). The other six species were included in the review as they were indicated by experts as being important for the local ecosystems and shall therefore be considered as target species. Moreover, of the 48 species reviewed here, 18 are marine or partially marine and therefore of more relevance for the ECOSS project.

From the information provided here, it is apparent that for most (81%) of the species there is at least some available peer reviewed literature (Figure 1) providing important facts about the species biology and ecology. However, when looking at marine or partially marine species only, information in peer reviewed literature exists for 65% of them (Figure 2). This is probably attributable to the fact that terrestrial studies are logistically and financially easier to conduct than their marine counterparts. Furthermore, the closer look reveals that the available literature pertains mostly to areas wider than the Natura 2000 sites. This is particularly the case for sites Tegnue di Chioggia and Trezze San Pietro e Bardelli, which with their small size encompass only a small portion of species' natural distribution range. Additionally, for several species, the literature is available only for nearby areas (see for example *Puffinus yelkouan* in Trezze San Pietro e Bardelli). Therefore, although there is knowledge for most of the species, for the needs of Natura 2000 sites management the information can only be extrapolated. This presents a potential deficiency in proper knowledge-based decision making. It is therefore of vital importance to direct future studies at data-deficient species, and particularly at the designated Natura 2000 sites.

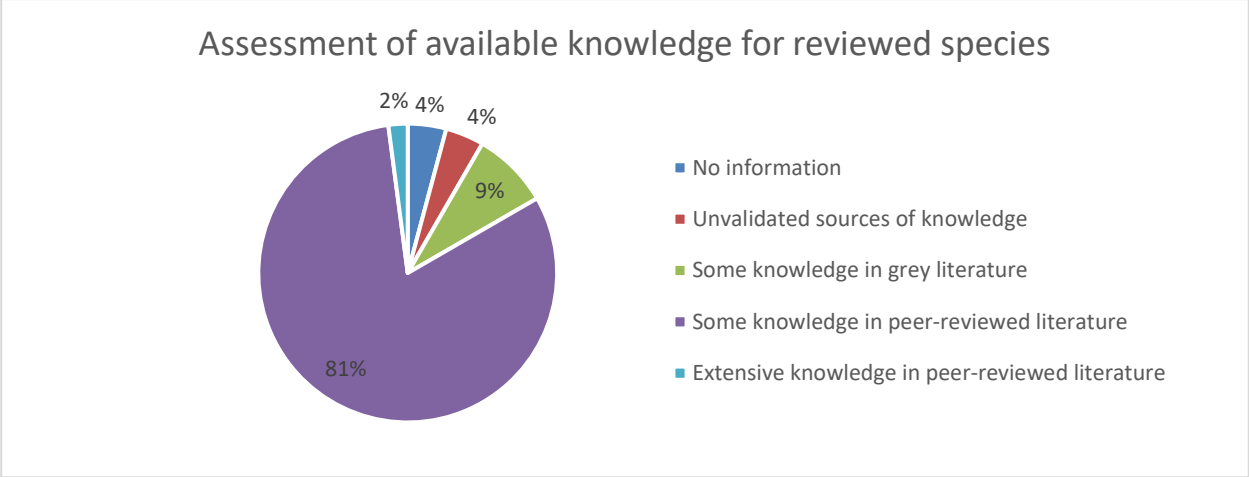

Figure 1 – Proportions of assessment categories of the knowledge on the Natura 2000 target species

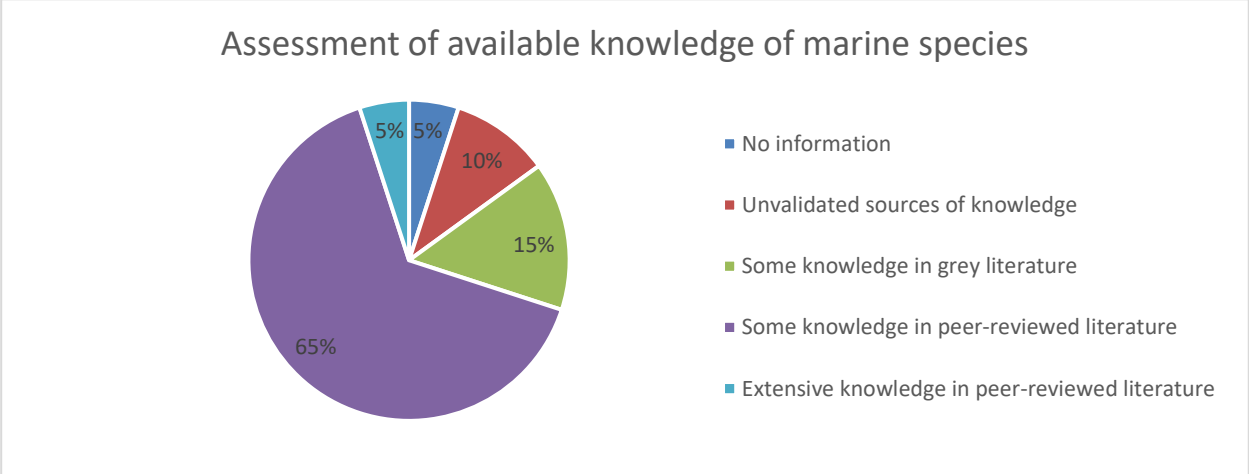

Figure 2 - Proportions of assessment categories of the knowledge on the marine and partially marine Natura 2000 target species

When considering the abundance (details in Table 1), one of the most relevant parameters to assess the conservation status of a species, the available information suggests a negative trend for 38% of all the reviewed species. Furthermore, there is lack of information on abundance for 27% of all the reviewed species (Figure 3). When looking at marine or partially marine species only, a negative trend is

confirmed or suspected for 10% of the species, and there is an absence of information on abundance for 55% of the species (Figure 4).
Based on this information, there is an obvious need for future studies to establish baseline information on the abundance of the Natura 2000 species to enable monitoring the trends in abundance and the influencing factors over time and inform the management plans of N2000 sites.

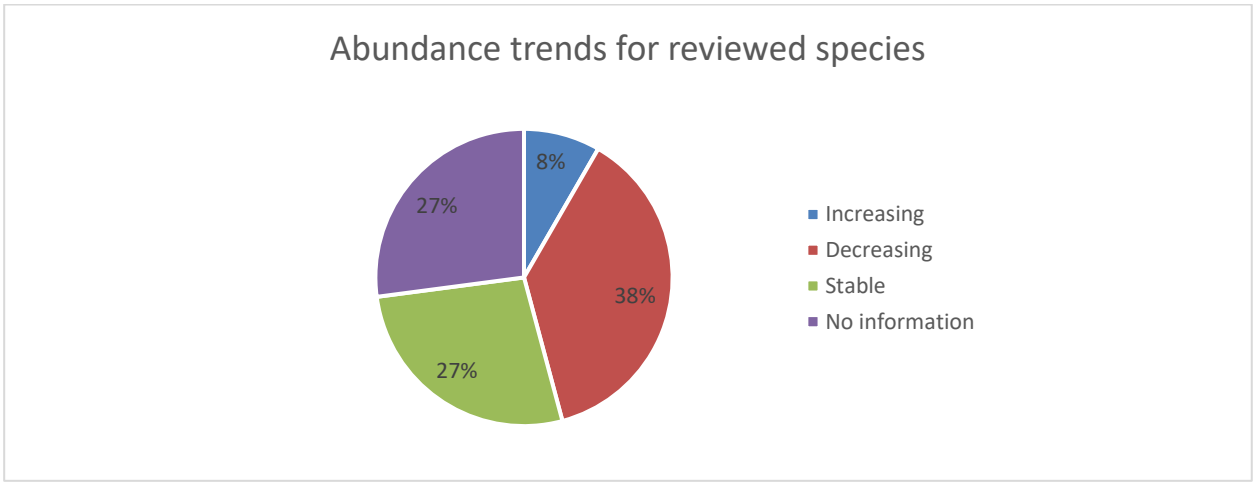

Figure 3 – Trends in abundance for the reviewed Natura 2000 target species

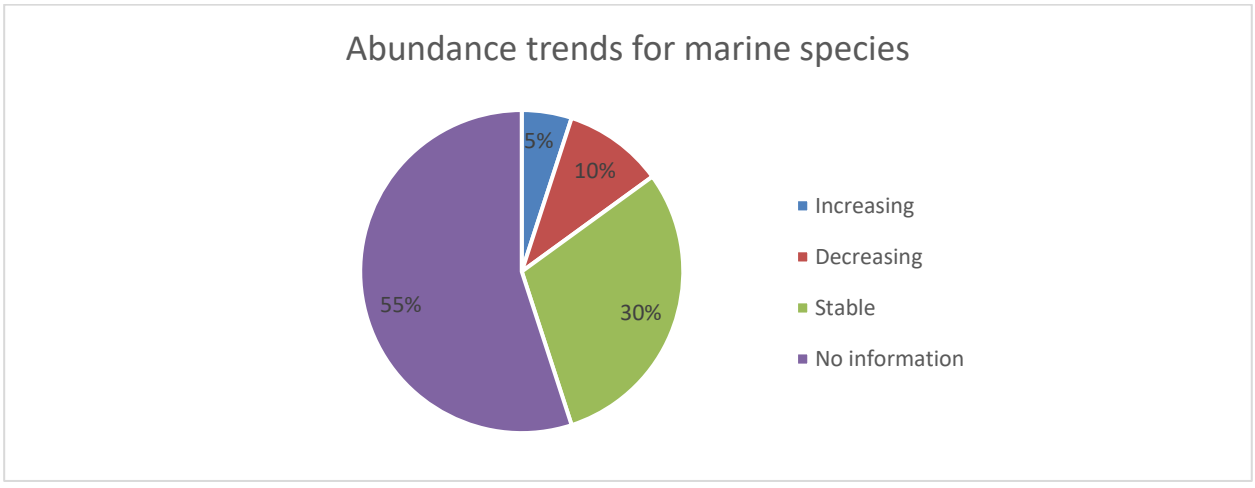

Figure 4 – Trends in abundance for the reviewed marine or partially marine Natura 2000 target species

Table 1 – List of reviewed species grouped per Natura 2000 site with indicated information on abundance and corresponding source, if available. “No Data” indicates that no published information on species abundance exists. Grey shading indicates species that are not listed as Natura 2000 target species in the Standard Data Forms, but were included for being assessed as important based on expert opinion.

Site	Latin name	English name	Taxon	Marine	Abundance	Source
Delta del Po	*Kosteletzkya pentacarpos*	Virginia saltmarsh mallow	Plant	No	Decreasing	Buord et al. 2011
Delta del Po	*Salicornia veneta*	Venice salicorne	Plant	No	No Data	Turin, Bioprogramm, pers. comm.
Delta del Po	*Acipenser naccarii*	Adriatic sturgeon	Fish	Yes	Decreasing	Bronzi et al. 2011
Delta del Po	*Alosa fallax*	Twait shad	Fish	Yes	Decreasing	Bianco et al. 2002
Delta del Po	*Knipowitschia panizzae*	Adriatic dwarf goby	Fish	Yes	Stable	Malavasi et al. 2005
Delta del Po	*Lampetra zanandreai*	Lombardy lamprey	Fish	No	No Data	Turin, Bioprogramm, pers. comm.
Delta del Po	*Petromyzon marinus*	Sea lamprey	Fish	Yes	No Data	Turin, Bioprogramm, pers. comm.
Delta del Po	*Pomatoschistus canestrinii*	Canestrini's goby	Fish	Yes	No Data	Turin, Bioprogramm, pers. comm.
Delta del Po	*Pelobates fuscus insubricus*	Common spadefoot	Amphibia	No	Decreasing	Spagnol et al. 2016
Delta del Po	*Emys orbicularis*	European pond turtle	Reptiles	No	Decreasing	Bonato et al 2007
Delta del Po	*Alcedo atthis*	Common kingfisher	Bird	No	Stable	Mezzavilla et al. 2016; Brichetti & Fracasso 2007
Delta del Po	*Ardea purpurea*	Purple heron	Bird	No	Decreasing	Mezzavilla et al. 2016
Delta del Po	*Ardeola ralloides*	Squacco heron	Bird	No	Stable	Mezzavilla et al. 2016
Delta del Po	*Botaurus stellaris*	Eurasian bittern	Bird	No	Stable	Mezzavilla et al. 2016
Delta del Po	*Caprimulgus europaeus*	European nightjar	Bird	No	Decreasing	Brichetti & Fracasso 2006; Mezzavilla et al. 2016

Delta del Po	*Chlidonias niger*	Black tern	Bird	No	Stable	Brichetti & Fracasso 2006
Delta del Po	*Circus aeruginosus*	Western marsh harrier	Bird	No	Decreasing	Wetlands International 2020
Delta del Po	*Circus cyaneus*	Hen harrier	Bird	No	Decreasing	Brichetti & No Fracasso 2003
Delta del Po	*Circus pygargus*	Montagu's harrier	Bird	No	Decreasing	Mezzavilla & Scarton 2005
Delta del Po	*Egretta alba*	Great egret	Bird	No	Stable	All. B DGR 1728/2012
Delta del Po	*Egretta garzetta*	Little egret	Bird	No	Decreasing	All. B DGR 1728/2012
Delta del Po	*Himantopus himantopus*	Black-winged stilt	Bird	No	Increasing	Scarton et al. 2009
Delta del Po	*Ixobrychus minutus*	Little bittern	Bird	No	No Data	Turin, Bioprogramm, pers. comm.
Delta del Po	*Nycticorax nycticorax*	Black-crowed night heron	Bird	No	Decreasing	Mezzavilla et al. 2016
Delta del Po	*Phalacrocorax pygmeus*	Pygmy cormorant	Bird	Yes	Increasing	Serra et al. 2000; Baccetti et al. 2002
Delta del Po	*Philomachus pugnax*	Ruff	Bird	No	No Data	Turin, Bioprogramm, pers. comm.
Delta del Po	*Phoenicopterus ruber*	American flamingo	Bird	No	Increasing	All. B DGR 1728/2012
Delta del Po	*Pluvialis apricaria*	European golden plover	Bird	No	No Data	Turin, Bioprogramm, pers. comm.
Delta del Po	*Recurvirostra avosetta*	Pied avocet	Bird	No	Stable	Scarton et al. 2005
Delta del Po	*Sterna albifrons*	Little tern	Bird	No	Increasing	Scarton et al. 2005
Delta del Po	*Sterna hirundo*	Common tern	Bird	No	Decreasing	Scarton 2010
Delta del Po	*Sterna sandvicensis*	Sandwich tern	Bird	No	No Data	Turin, Bioprogramm, pers. comm.
Delta del Po	*Charadrius alexandrinus*	Kentish plover	Bird	No	Decreasing	Brichetti & Fracasso 2004
Delta del Po	*Lanius collurio*	Red-backed shrike	Bird	No	Decreasing	Mezzavilla et al. 2016
Delta del Po	*Lanius minor*	Lesser grey shrike	Bird	No	No Data	Turin, Bioprogramm, pers. comm.
Tegnue di Chioggia	*Caretta caretta*	Loggerhead turtle	Reptilia	Yes	No Data	Fortuna et al. 2018

Tegnue di Chioggia	*Tursiops truncatus*	Common bottlenose dolphin	Mammal	Yes	Stable	Fortuna et al. 2018
Trezze San Pietro e Bardelli	*Geodia cydonium*	Geody	Sponge	Yes	Stable	Turicchia et al. 2013
Trezze San Pietro e Bardelli	*Cladoccora caespitosa*	Cushion coral	Coral	Yes	No Data	N/A
Trezze San Pietro e Bardelli	*Alosa fallax*	Twait shad	Fish	Yes	No Data	Saul Ciriaco, Shoreline, pers. comm.
Trezze San Pietro e Bardelli	*Caretta caretta*	Loggerhead turtle	Reptilia	Yes	No Data	Fortuna et al. 2018
Trezze San Pietro e Bardelli	*Puffinus yelkouan*	Yelkouan shearwater	Bird	Yes	No Data	Saul Ciriaco, Shoreline, pers. comm.
Trezze San Pietro e Bardelli	*Phalacrocorax aristotelis desmarestii*	European shag	Bird	Yes	No Data	Saul Ciriaco, Shoreline, pers. comm.
Trezze San Pietro e Bardelli	*Larus melanocephalus*	Mediterranean gull	Bird	Yes	No Data	Saul Ciriaco, Shoreline, pers. comm.
Trezze San Pietro e Bardelli	*Tursiops truncatus*	Common bottlenose dolphin	Mammal	Yes	Stable	Fortuna et al. 2018
Cres-Lošinj	*Tursiops truncatus*	Common bottlenose dolphin	Mammal	Yes	Stable	Pleslić et al. 2013
Vis	*Tursiops truncatus*	Common bottlenose dolphin	Mammal	Yes	Stable	Miočić-Stošić et al. 2019
Malostonski Bay	*Fucus virsoides*	Fucus	Algae	Yes	No Data	Marijana Pečarević, University of Dubrovnik, pers. comm.
Malostonski Bay	*Cymodocea nodosa*	Slender seagrass	Plant	Yes	Stable	Marijana Pečarević, University of Dubrovnik, pers. comm.
Malostonski Bay	*Litophaga litophaga*	Date mussel	Mollusc	Yes	No Data	Marijana Pečarević, University of Dubrovnik, pers. comm.
Malostonski Bay	*Pinna nobilis*	Noble penn shell	Mollusc	Yes	Decreasing	Marijana Pečarević, University of Dubrovnik, pers. comm.

13. LITERATURE

All. B DGR 1728/2012 - Veneto Region, ANNEX B Regional Council Resolution no. 1728 of 7 August 2012. Hunting wildlife planning for the period 2013-2018 (Articles 8 and 9 of L.R. 50/1993). Preliminary guidance document part three: knowledge framework and analysis of the regional wildlife potential (All. B DGR 1728/2012)

Arrigoni, P.V. 2006. Flora dell'Isola di Sardegna. Carlo Delfino, Sassari.

As.Fa.Ve (Associazione Faunisti Veneti), 2004. (Redattori: Bon M., Sighele M., Verza E.). Rapporto ornitologico per la Regione Veneto. Anno 2003. Boll. Mus. civ. St. nat. Venezia., 55: 171-200.

As.Fa.Ve (Associazione Faunisti Veneti), 2009. (Redattori: Sighele M., Bon M., Verza E.). Rapporto ornitologico per la Regione Veneto. Anno 2008. Boll. Mus. civ. St. nat. Venezia., 60: 143-168.

As.Fa.Ve (Associazione Faunisti Veneti), 2010. (Redattori: Sighele M., Bon M., Verza E.). Rapporto ornitologico per la Regione Veneto. Anno 2009. Boll. Mus. civ. St. nat. Venezia., 61: 83-115.

Baccetti, N., Capizzi, D., Corbi, F., Massa, B., Nissardi, S., Spano, G. & Sposimo, P. 2009. Breeding sherwaters on Italian islands: size, island selecion and coexistence with their main alien predator, the black rat. Riv. Ital.Orn., 78: 73-82

Baccetti, N., Dall'Antonia, P., Magagnoli, P., Melega, L., Serra, L., Soldatini, C. & Zenatello, M. 2002. Risultati dei censimenti degli uccelli acquatici svernanti in Italia: distribuzione, stima e trend delle popolazioni nel 1991-2000. Biol. Cons. Fauna, Bologna, 111: 1-240.

Barbera, C., Bordehore, C., Borg, J.A., Glemarec, M., Grall, J., HallSpencer, J.M., De la Huz, C., Lanfranco, E., Lastra, M., Moore, P.G., Mora, J., Pita, M.E., Ramos-Espla, A.A., Rizzo, M., Sanchez-Mata, A., Seva, A., Schembri, P.J. & Valle, C. 2003. Conservation and management of northeast Atlantic and Mediterranean maerl beds. Aquatic Conservation – Marine and Freshwater Ecosystems 13, S65–S76.

Basso, L., Vazquez-Luis, M., Garcia-March, J.R., Deudero, S., Alvarez, E., Vicente, N., Duarte, C.M. & Hendriks, I.E. 2015. The Pen Shell, *Pinna nobilis*: a review of population status and recommended research priorities in the Mediterranean Sea. Advaces in Marine Biology, 71, pp. 109-160

Battelli, C. 2016. Disappearance of *Fucus virsoides* J. Agardh from the Slovenian coast (Gulf of Trieste, Northern Adriatic). Series Historia Naturalis, 26(1): 1-10.

Betti, F. 2013. Fiori Sott'acqua – Gli antozoi dell'Area Marina Protetta "Isola di Bergeggi". Editoriale Darsena Savona pp. 1-112

Bianco, P.G. 1986. *Lethenteron zanandreai* (Vladykov, 1955). p. 237-246. In J. Holcík (ed.) The freshwater fishes of Europe. Vol. 1, Part 1. Petromyzontiformes.

Bianco, P.G. 2002. The status of the twaite shad, *Alosa agone*, in Italy and the western Balkans.

BirdLife International. 2004. Birds in Europe: population estimates, trends and conservation status.

Blake, C. & Maggs, C.A. 2003. Comparative growth rates and internal banding periodicity of maerl species (Corallinales, Rhodophyta) from northern Europe. Phycologia 42, 606–612.

Boitani, L., Corsi, F., Falcucci, A., Maiorano, L., Marzetti, I., Masi, M., Montemaggiori, A., Ottaviani, D., Reggiani, G. & Rondinini, C. 2002. Rete Ecologica Nazionale. Un approccio alla conservazione dei vertebrati italiani Università di Roma "La Sapienza", Dipartimento di Biologia Animale e dell'Uomo; Ministero dell'Ambiente, Direzione per la Conservazione della Natura. Istituto di Ecologia Applicata, Roma

Bon, M., Cherubini, G., Semenzato, M. & Stival, E. 2000. Atlante degli uccelli nidificanti in provincia di Venezia. Provincia di Venezia. Pp. 160.

Boschetti, E., Richard, J., Bonato, L. 2006. Una popolazione relitta di *Pelobates fuscus insubricus* in un sito litoraneo veneto (Amphibia, Pelobatidae). Gortania, Atti Mus. Friul. St. Nat., 27 (2005): 339-345.

Bourgeois, K. & Vidal, E. 2008. The endemic Mediterranean yelkouan shearwater *Puffinus yelkouan*: distribution, threats and a plea for more data. Oryx, 42(2), 187-194.

Briand, X. 1991. Seaweed harvesting in Europe. In: Guiry, M.D., Blunden, G. (Eds.), Seaweed Resources in Europe. Wiley, Chichester, pp. 259–308.

Buchel, C., Wilhelm, C., 1993. In vivo analysis of slow chlorophyll fluorescence induction kinetics in algae: progress, problems and perspectives. Photochemistry and Photobiology 58, 137–148.

Brichetti, P. & Fracasso, G. 2003. Ornitologia italiana - Gavidae-Falconidae. Alberto Perdisa Editore, Bologna

Brichetti, P. & Fracasso, G. 2004. Ornitologia italiana - Tetraonidae-Scolopacidae Alberto Perdisa Editore, Bologna

Brichetti, P. & Fracasso, G. 2006. Ornitologia Italiana - Stercorariidae-Caprimulgida. Alberto Perdisa Editore, Bologna.

Brichetti, P. & Fracasso, G. 2007. Ornitologia italiana - Apodidae-Prunellidae. Alberto Perdisa Editore, Bologna

Brichetti, P. & Fracasso, G. 2011. Ornitologia italiana – Paridae-Corvidae. Alberto Perdisa Editore, Bologna

Bronzi, P., Congiu, L., Rossi, R., Zerunian, S. & Arlati, G. 2011. *Acipenser naccarii*. IUCN Red List of Threatened Species.

Buffa, G., Carpenè, B., Casarotto, N., Da Pozzo, M., Filesi, L., Lasen, C., Marcucci, R., Masin, R., Prosser, F., Tasinazzo, S., Villani, M. & Zanatta, K. 2016. Lista rossa regionale delle piante vascolari. Regione del Veneto. Regione del Veneto e Società Botanica Italiana.

Buia, M.C. & Mazzella, L. 1991. Reproductive phenology of the Mediterranean seagrasses *Posidonia oceanica* (L.) Delile, *Cymodocea nodosa* (Ucria) Aschers., and *Zostera noltii* Hornem. Aquatic Botany. 40 (4): 343–362

Buord, S., Gargano, D. & Moreno Saiz, J.C. 2011. *Kosteletzkya pentacarpos*. The IUCN Red List of Threatened Species 2011: Downloaded on 27 April 2020.

Caputo, V., Giovannotti, M., Nisi Cerioni, P., Splendiani, A., Marconi, M. & Tagliavini, J. 2009. Mitochondrial DNA variation of an isolated population of the Adriatic brook lamprey *Lampetra zanandreai* (Agnatha: Petromyzontidae): phylogeographic and phylogenetic inferences. Joural of Fish Biology 75: 2344-2351

Casado de Amezua, P., Kersting, D., Linares, C.L., Bo, M., Caroselli, E., Garrabou, J., Cerrano, C., Ozalp, B., Terrón-Sigler, A. & Betti, F. 2015. *Cladocora caespitosa*. The IUCN Red List of Threatened Species 2015: Downloaded on 25 April 2020.

Casale, P., Broderick, A. C., Camiñas, J. A., Cardona, L., Carreras, C., Demetropoulos, A., ... & Lazar, B. 2018. Mediterranean sea turtles: current knowledge and priorities for conservation and research. Endangered species research, 36, 229-267.

Catanese, G., Grau, A., Maria Valencia, J., Garcia-March, J.R., Alvarez, E., Vazquez-Luis, M., Deudero, S., Darriba, S., Carballal, M.J. & Villalba, A. 2018. *Haplosporidium pinnae sp. nov*., a haplosporidan parasite

associated with mass mortalities of the fan mussel, *Pinna nobilis*, in the Western Mediterranean Sea J. Invertebr. Pathol., 157, pp. 9-24, 10.1016/j.jip.2018.07.006

Ceccherelli, G., Campo, D. & Piazzi, L. 2001. Some ecological aspects of the interoduced alga *Caulerpa racemosa* in the Mediterranean: way of dispersal and impact on native species. Biologia Marina Mediterranea 8(1): 94-99

Chapman, A.S. & Fletcher, R.L. 2002. Differential effects of sediments on survival and growth of *Fucus serratus* embryos (Fucales, Phaeophyceae). Journal of Phycology 38, 894–903.

Chauvaud, L., Jean, F., Ragueneau, O. & Thouzeau, G. 2000. Long term variation of the Bay of Brest: benthic–pelagic coupling revisited. Marine Ecology Progress Series 200, 35–48.

Ciuffardi, L., Monaci, E., Balduzzi, A., Mori, M., & Arillo, A. 2007. Stato di conservazione della popolazione di Lampreda di mare nel bacino del Magra-Vara (Provincia della Spezia). Biologia Ambientale, 21(2), 107-112.

Cormaci, M., Furnari, G., Catra, M., Alongi, G. & Giaccone, G. 2012. Flora marina bentonica del Mediterraneo: Phaeophyceae. Bollettino dell'Accademia Gioenia 45: 1-508.

Corti, C., Capula, M., Luiselli, L., Razzetti, E. & Sindaco, R. 2010. Fauna d'Italia, Reptilia Calderini, Bologna

Coscia, I., Rountree, V., King, J.J., Roche, W.K. & Mariani, S., 2010. A highly permeable species boundary between two anadromous fishes. Journal of Fish Biology: 1137-149.

Cosolo, M., Privileggi, N., Cimador, B. & Sponza, S. 2011. Dietary changes of Mediterranean Shags *Phalacrocorax aristotelis desmarestii* between the breeding and post-breeding seasons in the upper Adriatic Sea. Bird Study, 58(4), 461-472.

Cosolo, M., Privileggi, N., Cimador, B. & Sponza, S. 2012. The importance of diet specialization for the feeding ecology of the Mediterranean Shag *Phalacrocorax aristotelis desmarestii* in the upper Adriatic Sea. Ecology and Conservation of Mediterranean Seabirds, 111.

Crottini, A. & Andreone, F. 2007. Conservazione di un anfibio iconico: lo status di *Pelobates fuscus* in Italia e linee guida d'azione. Quad. Staz. Ecol. Civ. Mus. St. Nat. Ferrara. 17: 67–76.

Curiel, D., Falace, A., Bandelj, V., Kaleb, S., Solidoro, C., & Ballesteros, E. 2012. Species composition and spatial variability of macroalgal assemblages on biogenic reefs in the northern Adriatic Sea. Botanica Marina, 55(6), 625-638.

Davenport, J., Ezgeta-Balić, D., Peharda, M., Skejić, S., Ninčević-Gladan, Ž. & Matijević, S. 2011. Size-differential feeding in *Pinna nobilis* L. (Mollusca: Bivalvia): Exploitation of detritus, phytoplankton and zooplankton. Estuarine, Coastal and Shelf Science 92, 246-254

De Gaulejac, B., 1995. Successive hermaphrodism with asynchronous maturation *Pinna nobilis* (L.) (Bivalvia: Pterioidea). Comptes Rendus de l'Academie des Sciences Paris—Series III. Sciences de la vie. Biol. Pathol. Anim. 318, 99–103

Devescovi, M. & Iveša, L. 2008.Colonization patterns of the date mussel *Lithophaga lithophaga* (L., 1758) on limestone breakwater boulders of a marina. Period. Biol. 110, 339–345

Devescovi, M. 2009. Biometric diferences between date mussels *Lithophaga lithophaga* colonizing artifcial and natural structures. Acta Adriat. 50, 129–138

Ercole, S., Giacanelli, V., Bertani, G., Brancaleoni, l., Croce, A., Fabrini, G., Gerdol, R., Ghirelli, L., Masin, R., Mion, D., Santangelo, A., Sburlino, G., Tomei, P.E., Villani, M. & Wagensommer, R.P. 2013. *Kosteletzkya pentacarpos* (L.) Ledeb. Informatore BotanIco Italiano, 45 (1) 115-193, 2013. Schede per una Lista Rossa della Flora vascolare e crittogamica Italiana.

Falace, A., Kaleb, S., Curiel, D., Miotti, C., Galli, G., Querin, S., ... & Bandelj, V. (2015). Calcareous bio-concretions in the northern Adriatic Sea: habitat types, environmental factors that influence habitat distributions, and predictive modeling. PLoS One, 10(11).

Fasola, M., Albanese, G., ASOER, Boano, G., Boncompagni, E., Bressan, U., Brunelli, M., Ciaccio, A., Floris, G., Grussu, M., Guglielmi, R., Guzzon, C., Mezzavilla, F., Paesani, G., Sacchetti, A., Sanna, M., Scarton, F., Scoccianti, C., Utmar, P., Vaschetti, G. & Velatta, F. 2007. Le garzaie in italia. 2002 Avocetta, 31: 5-46

Fasola, M., Albanese, G., Boano, G., Boncompagni, E., Bressan, U., Brunelli, M., Ciaccio, A., Floris, G., Grussu, M., Guglielmi, R., Guzzon, C., Mezzavilla, F., Paesani, G., Sacchetti, A., Sanna, M., Scarton, F., Scoccianti, C., Utmar, P., Vaschetti, G., Velatta, F. 2007. Le garzaie in Italia 2002. Avocetta, 31: 5-46.

Fasola, M., Bogliani, G., Saino, N. & Canova, L. 1989. Foraging, feeding and time-activity niches of eight species of breeding seabirds in the coastal wetlands of the Adriatic Sea. Italian Journal of Zoology, 56(1), 61-72.

Fasola, M., Rubolini, D., Merli, E. Boncompagni, E. & Bressan, U. 2010. Long-term trends of heron and egret populations in Italy, and the effects of climate, human-induced mortality, and habitat on population dynamics. Population Ecology, 52: 59-72.

Ficetola, G.F. & De Bernardi, F., 2006. Is the European "pond" turtle *Emys orbicularis* strictly aquatic and carnivorous?. Amphibia-Reptilia. 27 (3): 445–447.

Fiorin, R., Riccato, F., Colla, S., Bragato, A. & Salvagno, A. 2017. *Petromyzon marinus* (Linnaeus, 1758): nuove segnalazioni per il nord Adriatico (Agnatha, Petromyzontiformes, Petromyzontidae). Bollettino del Museo di Storia Naturale di Venezia, 68: 99-100

Fortuna, C. M., Cañadas, A., Holcer, D., Brecciaroli, B., Donovan, G. P., Lazar, B., ... & Mackelworth, P. C. 2018. The coherence of the European Union marine Natura 2000 network for wide-ranging charismatic species: a Mediterranean case study. Frontiers in marine science, 5, 356.

Franco, A., Franzoi, P., Malavasi, S., Riccato, F. & Torricelli, P. 2006. Fish assemblages in different shallow water habitats of the Venice Lagoon. Hydrobiologia, 555: 159–174.

Freyhof, J. 2018. *Ninnigobius canestrinii* (amended version of 2011 assessment). The IUCN Red List of Threatened Species 2018: Downloaded on 28 April 2020.

Fry, K., Harris, A. & Fry, H. 1999. Kingfishers, Bee-eaters and Rollers. London: Christopher Helm. pp. 219–221.

Galinou-Mitsoudi, S. & Sinis, A.I. 1994. Reproductive-cycle and fecundity of the date mussel *Lithophaga lithophaga* (Bivalvia: Mytilidae). Journal of Molluscan Studies, 60, 371–385

Gordini, E., Falace, A., Kaleb, S., Donda, F., Marocco, R., & Tunis, G. 2012. Methane-related carbonate cementation of marine sediments and related macroalgal coralligenous assemblages in the Northern Adriatic Sea. In Seafloor Geomorphology as Benthic Habitat (pp. 185-200). Elsevier.

Guidetti, P., Buia, M. C., Lorenti, M., Scipione, M. B., Zupo, V., & Mazzella, L. 2001. Seasonal trends in the Adriatic seagrass communities of *Posidonia oceanica* (L.) Delile, *Cymodocea nodosa* (Ucria) Ascherson, *Zostera marina* L.: plant phenology, biomass partitioning, elemental composition and faunal features. In Mediterranean Ecosystems (pp. 289-295). Springer, Milano.

Iveša, Lj., Lyons, D.M. & Devescovi, M. 2009. Assessment of the ecological status of north-eastern Adriatic coastal waters (Istria, Croatia) using macroalgal assemblages for the European Union Water Framework Directive. Aquatic Conservation: Marine and Freshwater Ecosystems 19:14-23.

Kennedy, H., Richardson, C.A., Duarte, C.M. & Kennedy, D.P. 2001. Diet and association of *Pontonia pinnophylax* occurring in Pinna nobilis: insights from stable isotope analysis. Journal of the Marine Biological Association of the United Kingdom. 81 (1): 177–178.

Kersting, D., Benabdi, M., Čižmek, H., Grau, A., Jimenez, C., Katsanevakis, S., Öztürk, B., Tuncer, S., Tunesi, L., Vázquez-Luis, M., Vicente, N. & Otero Villanueva, M. 2019. *Pinna nobilis*. The IUCN Red List of Threatened Species 2019: Downloaded on 14 April 2020.

Koce, U. 2018. New marine IBAs for the Mediterranean Shag *Phalacrocorax aristotelis desmarestii* in Slovenia. Acrocephalus, 39(178-179), 101-128.

Koks, B., Tierweiler, C., Visser, E., Dijkstra, C. & Komdeur, J. 2007. Do voles make agricultural habitat attractive to Montagu's Harrier *Circus pygargus*? Ibis 149:575-586.

Kottelat, M. & Freyhof, J. 2007. Handbook of European Freshwater Fishes. Publications Kottelat, Cornol (CH).

Kružić, P. & Požar-Domac, A. 2003. Banks of the coral *Cladocora caespitosa* (Anthozoa, Scleractinia) in the Adriatic Sea. Coral Reef n.(4) pp. 536

Kružić, P., & Benkovic, L. 2008. Bioconstructional features of the coral *Cladocora caespitosa* (Anthozoa, Scleractinia) in the Adriatic Sea (Croatia). Marine Ecology n.(1) pp. 125-139

Kružić, P., Žuljević, A. & Nikolić, V. 2008. Spawning of the colonial coral *Cladocora caespitosa* (Anthozoa, Scleractinia) in the Southern Adriatic Sea. Coral Reefs n.(2) pp. 337-341

Lanza, B., Andreone, F., Bologna, M.A., Corti, C. & Razzetti, E. 2007. Fauna d'Italia, Amphibia Calderini, Bologna

Lazar, B. & Tvrtković, N. 2003. Corroboration of the critical habitat hypothesis for the loggerhead sea turtle *Caretta caretta* in the eastern Adriatic Sea. In: Proceedings of the First Mediterranean Conference on Marine Turtles. Barcelona Convention–Bern Convention–Bonn Convention (CMS), pp. 165-169.

Lazar, B., Gračan, R., Katić, J., Zavodnik, D., Jaklin, A. & Tvrtković, N. 2011. Loggerhead sea turtles (*Caretta caretta*) as bioturbators in neritic habitats: an insight through the analysis of benthic molluscs in the diet. Marine Ecology, 32(1), 65-74.

Lazar, B., Margaritoulis, D. & Tvrtković, N. 2004. Tag recoveries of the loggerhead sea turtle *Caretta caretta* in the eastern Adriatic Sea: implications for conservation. Journal of the Marine Biological Association of the United Kingdom, 84(2), 475-480.

Linardić, J. 1949. Studije o jadranskom fukusu (*Fucus virsoides*). Acta Botanica, 12, 13, 7-131.

LIPU & Rete Rurale Nazionale 2011. www.mito2000.it

Lochet, A., Boutry, S. & Rochard, E., 2009. Estuarine phase during seaward migration for Allis Shad *Alosa alosa* and Twaite Shad *Alosa fallax* future spawners. Ecology of Freshwater Fish, 18: 323-35.

Maccagnani, R., Carrieri, A., Franzoi, P. & Rossi R. 1985. Osservazioni sulla strutturadi popolazione ed il ruolo trofico di tre specie di gobidi (*Knipowitschia panizzae*, *Pomatoschistus marmoratus*, *Pomatoschistus canestrinii*) in un ambiente del Deltadel Po.Nova Thalassia3,373–378.

Mačić, V. 2006. Distribution of seaweed *Fucus virsoides* J. Agardh in Boka Kotorska Bay (South Adriatic Sea). Series historia naturalis 16: 1-4.

Malavasi, S., Fiorin, R., Franco, A., Franzoi, P., Granzotto, A., Riccato, F. & Mainardi, D. 2004. Fish assemblages of Venice Lagoon shallow waters: an analysis based on species, families and functional guilds. Journal of Marine Systems, 51: 19-31.

Malavasi, S., Franco, A., Fiorin, R., Franzoi, P., Torricelli, P. & Mainardi, D. 2005. The shallow water gobiid assemblage of the Venice Lagoon: abundance, seasonal variation, and habitat partitioning. Journal of Fish Biology, 67 (Supplement B): 146-165.

Martelli, D. & Rigacci, L. 2005. Aggiornamento dello status del falco di plaude in Italia Avocetta n.29 pp. 117

Martin, C. S., Giannoulaki, M., De Leo, F., Scardi, M., Salomidi, M., Knittweis, L., ... & Fraschetti, S. 2014. Coralligenous and maërl habitats: predictive modelling to identify their spatial distributions across the Mediterranean Sea. Scientific Reports, 4, 5073.

Masin, R., Bertani, G., Cassanego, L., Favaro, G. & Tietto, C. 2008. Indagini sulla flora vascolare del Delta veneto del Po e dei territori limitrofi (Italia Nord Orientale). Natura Vicentina, 12: 5-94.

Masin, R., Bertani, G., Favaro, G., Pellegrini, B., Tietto, C. & Zampieri, A.M. 2009. Annotazioni sulla flora della Provincia di Venezia. Natura Vicentina, 13: 5-106.

Mercurio, M., Corriero, G., & Gaino, E. 2006. Sessile and non-sessile morphs of *Geodia cydonium* (Jameson) (Porifera, Demospongiae) in two semi-enclosed Mediterranean bays. Marine Biology, 148(3), 489-501.

Mezzavilla, F. & Scarton, F. 2005. Status in Veneto degli uccelli nidificanti ed applicazione di indici in alcune zone di protezione speciale (ZPS) del Veneto. In: Bon M., Dal Lago A., Fracasso G., (red.), Atti 4° Convegno Faunisti Veneti. Associazione Faunisti Veneti, Natura Vicentina n. 7: 17-26.

Mezzavilla, F., Scarton, F. & Bon M. 2016. Gli uccelli del Veneto. Ed. Danilo Zanetti. 433pp

Miočić-Stošić, J., Pleslić, G. & Holcer, D. 2020. Sea Lamprey (*Petromyzon marinus*) Attachment to the Common Bottlenose Dolphin (*Tursiops truncatus*). Aquatic Mammals, 46(2). DOI 10.1578/AM.46.2.2020

Mitrus, S. 2006. Fidelity to nesting area of the European pond turtle, *Emys orbicularis* (Linnaeus, 1758). Belgian Journal of Zoology. 136 (1): 25–30.

Mizzan, L., Vianello, C. 2007. Biodiversità della Laguna di Venezia segnalazione n. 199 *Petromyzon marinus* (Linnaeus,1758) (Agnatha Petromyzontiformes Petromyzontidae). Boll. Mus. civ. St. nat. Venezia, 58: 326.

Morton, B. & Scott, P.J.B. 1980. Morphological and functional specializations of the shell, musculature and pallial glands in the Lithophaginae (Mollusca, Bivalvia). J. Zool. 192, 179–203

Orlando-Bonaca, M., Francé, J., Mavrič, B., Grego, M., Lipej, L., Flander-Putrle, V., ... & Falace, A. 2015. A new index (MediSkew) for the assessment of the *Cymodocea nodosa* (Ucria) Ascherson meadow's status. Marine environmental research, 110, 132-141.

Orlando-Bonaca, M., Mannoni, P.A. & Poloniato, D. 2013. Assessment of *Fucus virsoides* distribution in the Gulf of Trieste (Adriatic Sea) and its relation to environmental variables. Botanica Marin, 56(5-6): 451-459.

Panella, G. & Macclintock, C. 1968. Biological and environmental rhythms reflected in molluscan shell growth. Paleontological Society Memoir, 2: 64-81.

PECBMS. 2011. Population trends of common European Breeding Birds 2011. CSO, Prague.

Peirano, A., Morri, C., Bianchi, C.N., Aguirre, J., Antonioli, F., Calzetta, G., ... & Orrù, P. 2004. The Mediterranean coral *Cladocora caespitosa*: a proxy for past climate fluctuations? Global and planetary Change n.(1) pp. 195-200

Peris, S.J. & Rodriguez, R. 1996. Some factors related to distribution by breeding Kingfisher (*Alcedo atthis* L.). Ekologia Polska, 54 (1–2): 31–38.

Pignatti S. 1982. Flora d'Italia. vol. 2. edagricole, Bologna.

Porcellotti, S. 2005. Pesci d'Italia. Ittiofauna delle acque dolci. Edizioni PLAN, pp 80-81.

Pulcher, C. 1986. Mignattino Suppl. Ric. Biol. Selvaggina, 11: 129-136

Raine, A.F., Borg, J.J., Raine, H., & Phillips, R.A. 2013. Migration strategies of the Yelkouan Shearwater *Puffinus yelkouan*. Journal of Ornithology, 154(2), 411-422.

Rodolfo-Metalpa, R., Martin, S., Ferrier-Pagès, C. & Gattuso, J.P. 2010. Response of the temperate coral *Cladocora caespitosa* to mid-and long-term exposure to pCO_2 and temperature levels projected for the year 2100 AD. Biogeosciences n.(1)

Rodolfo-Metalpa, R., Richard, C., Allemand, D., Bianchi, C.N., Morri, C. & Ferrier-Pages, C. 2006. Response of zooxanthellae in symbiosis with the Mediterranean corals *Cladocora caespitosa* and *Oculina patagonica* to elevated temperatures. Marine Biology n.(1) pp. 45-55

Scarton, F. & Valle, R. 1996. La Beccaccia di mare torna a nidificare in laguna di Venezia. Riv. ital. Orn. 66:202-203.

Scarton, F. & Valle, R. 1999. The use of dredge islands by birds in northern Adriatic lagoons. Avocetta-Parma, 23, 75-75.

Scarton, F. 2010. Long term decline of a Common Tern (*Sterna hirundo*) population nesting in salt marshes in Venice lagoon, Italy. Wetlands 30: 1153 – 1159.

Scarton, F., Baldin, M. & Valle, R. 2009. L'avifauna acquatica nidificante nelle barene artificiali della laguna di Venezia. Boll. Mus. civ. St. nat. Venezia 60:127-141.

Scarton, F., Boschetti, E., Guzzon, C., Kravos, K., Panzarin, L., Utmar, P., Valle, R. & Verza, E. 2005. Caradriformi e volpoca, *Tadorna tadorna*, nidificanti sulle coste del Nord Adriatico (Friuli Venezia-Giulia e Veneto) nel triennio 2000-2002. Riv. ital. Orn. 75: 23-38.

Scoppola A. & Spampinato G. 2005. Atlante delle specie a rischio di estinzione. In: A. Scoppola and C. Blasi (eds). Stato delle conoscenze sulla flora vascolare d'Italia. Palombi Editori, Roma.

Serra, L. & Brichetti, P. 2000. Uccelli acquatici nidificanti: 1999. Avocetta, 24 (2): 133-138.

Sfriso, A. (1987). Flora and vertical distribution of macroalgae in the lagoon of Venice: a comparison with previous studies. *Plant Biosystem*, *121*(1-2), 69-85.

Sfriso, A., & Facca, C. (2007). Distribution and production of macrophytes and phytoplankton in the lagoon of Venice: comparison of actual and past situation. In *Lagoons and Coastal Wetlands in the Global Change Context: Impacts and Management Issues* (pp. 71-85). Springer, Dordrecht.

Short, F.T., Carruthers, T.J.R., Waycott, M., Kendrick, G.A., Fourqurean, J.W., Callabine, A., Kenworthy, W.J. & Dennison, W.C. 2010. *Cymodocea nodosa*. The IUCN Red List of Threatened Species 2010: Downloaded on 20 April 2020.

Short, F.T., Dennison, W.C., Carruthers, T.J.B. & Waycott, M. 2007. Global seagrass distribution and diversity: a bioregional model. Journal of Experimental Marine Biology and Ecology 350: 3-20

Silva, S., Araújo, M.J., Bao, M., Mucientes, G. & Cobo, F. 2014. The haematophagous feeding stage of anadromous populations of sea lamprey *Petromyzon marinus*: low host selectivity and wide range of habitats. Hydrobiologia. 734 (1): 187–199.

Silva, S., Servia, M.J., Vieira-Lanero, R. & Cobo F., 2013a. Downstream migration and hematophagous feeding of newly metamorphosed sea lampreys (*Petromyzon marinus* Linnaeus, 1758). Hydrobiologia, 700: 277–286.

Silva, S., Servia, M.J., Vieira-Lanero, R., Nachón, D.J. & Cobo, F. 2013b. Hematophagous feeding of newly metamorphosed European sea lampreys *Petromyzon marinus* on strictly freshwater species. Journal of Fish Biology. 82 (5): 1739–1745.

Silva, S., Servia, M.J., Vieira-Lanero, R., Barca, S. & Cobo, F., 2013c. Life cycle of the sea lamprey *Petromyzon marinus*: duration of and growth in the marine life stage. Aquatic Biology. 18: 59–62.

Societas Herpetologica Italica. 1996. Atlante prowisorio degli Anfibi e dei Rettili italiani. Annali Mus. Civ. St. Nat. "G. Doria" 91: 95-178.

Sponza, S., Cosolo, M. & Kralj, J. 2013. Migration patterns of the Mediterranean Shag *Phalacrocorax aristotelis desmarestii* (Aves: Pelecaniformes) within the northern Adriatic Sea. Italian journal of zoology, 80(3), 380-391.

Šimunović, A. & Grubelić, I. 1992. Biological and ecological studies of date shell (*Lithophaga lithophaga* L.) from the Eastern Adriatic Sea. Period. Biol. 94, 187–192

Šimunović, A., Grubelić, I., Tudor, M. & Hrs-Brenko, M. 1990. Sexual cycle and biometry of date shell, *Lithophaga lithophaga* Linnaeus (Mytilidae). Acta Adriat. 31, 139–151

Škornik, I., Utmar, P., Kravos, K., Candotto, S. & Crnković, R. 2012. Important post-breeding roosting area of Mediterranean Shag *Phalacrocorax aristotelis desmarestii* in Gulf of Trieste (N Adriatic). Ecology and Conservation of Mediterranean Seabirds, 117.

Turicchia, E., Poli, D., Abbiati, M. & Ponti M. 2013. Abundance, size, and growth rate of *Geodia cydonium* (Demospongiae: Geodiidae) in the northern Adriatic temperate biogenic reefs. Rapport du 40e Congrès de la Commission Internationale pour l'Exploration Scientifique de la mer Méditerranée, p 699

Turin, P. 2010. Carta Ittica della Provincia di Rovigo – Acque interne. Vol. 2. Relazione tecnica. Provincia di Rovigo, 428 pp

Verza, E. & Cattozzo, L. 2015. Atlante lagunare costiero del Delta del Po. Regione Veneto, Associazione culturale naturalistica Sagittaria, Consorzio di Bonifica Delta del Po.

Verza, E. 2004. Uccelli acquatici nidificanti nel Delta del Po. Censimento 2004 dell'avifauna acquatica nidificante nel Delta del Po, provincia di Rovigo, e prima nidificazione accertata di beccapesci (Sterna sandvicensis) e pernice di mare (Glareola pratincola).

Zavodnik, D., Hrs-Brenko, M. & Legac, M. 1991. Synopsis of the fan shell *Pinna nobilis* L. in the eastern Adriatic Sea. In the C. F. Boudouresque, M. Avon, & V. Gravez (Eds.), Les Especes Marines a Proteger en Mediterranee. Marseille, France: GIS Posidonie publ. 169–178

Zavodnik, N., Iveša, Lj. & Travizi, A. 2002. Note on recolonisation by fucoid algae *Cystoseira spp*. and *Fucus virsoides* in the North Adriatic Sea. Acta Adriatica 43(1): 25-32.

Zerunian, S. 2002. Condannati all'estinzione? Biodiversità, biologia, minacce e strategie di conservazione dei Pesci d'acqua dolce indigeni in Italia. Edagricole, pp 108-109.

Zuffi, M.A.L. 2000. Conservation biology of the European pond turtle *Emys orbicularis* (L) in Italy. Stapfia 69, Zugleich kataloge des oö. Landesmuseums, Neue folge nr. 149: 219-228.

Žuljević, A. Despalatović, M., Cvitković, I., Morton, B. & Antolić, B. 2018. Mass spawning by the date mussel *Lithophaga lithophaga*. Scientific Reports 8:2045-2322

14. ANNEXES

Annex I

The questionnaire for collecting the available information on the selected Natura 2000 taget species.

Site Name:

Target species 1

English name:
Latin name:
Short description of biology and/or life-cycle:
Relevance for Natura 2000 site:
Relevance for the whole Adriatic:
Please rate the existing knowledge about this species at this N2K site (bold your selection):

1. Nothing is known about this species at this site
2. There are some unvalidated sources of knowledge
3. There is some knowledge in grey literature
4. There is some knowledge in peer reviewed literature
5. There is a rich body of peer reviewed literature about this species at this site

Species' abundance at the N2K site:

1. Increasing
2. Decreasing
3. Stable
4. N/A

Species' spatial distribution at the N2K site:

1. Uniformly distributed across the site
2. Patchy distributed across the site
3. Other:
4. N/A

Species' temporal distribution at the N2K site:

1. Present year-round
2. Seasonal presence (please indicate (bold): Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec)
3. Occasional/Irregular visitor
4. Other:
5. N/A

What aspect of this target species' biology or relevance for the N2K site should have priority in further research?

Please list relevant literature on the species: